The
Edinburgh Philosophical
Journal. Vol-3
1820

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THE

EDINBURGH

PHILOSOPHICAL JOURNAL.

ART. I.—*On Isothermal Lines, and the Distribution of Heat over the Globe.* By Baron ALEXANDER DE HUMBOLDT *.

THE distribution of heat over the Globe belongs to that kind of phenomena, of which the general circumstances have been long known, but which were incapable of being rigorously determined or submitted to exact calculation, till experience and observation furnished data from which the theory might obtain the corrections and the different elements which it requires. The object of this memoir is to facilitate the collection of these data, to present results drawn from a great number of unpublished observations, and to group them according to a method which has not yet been tried, though its utility has been recognised for more than a century in the exposition of the phenomena of the variation and dip of the magnetic needle. As the discussion of individual observations will be published in a separate work, I shall at present limit myself to a simple sketch of the distribution of heat over the globe, according to the most recent and accurate data. Although we may not be able to refer the complex phenomena to a general theory, it

* As this interesting and valuable Memoir, the original of which was published in the *Memoires D'Arcueil*, tom. iii. p. 462, has never appeared in our language, and as it must be constantly referred to in all subsequent speculations on Meteorology, and should be familiar to every person who pursues this important study, we have resolved to present a translation of it to our readers. A small part of the memoir appeared in an English journal; but almost all the reductions from the Centigrade to Fahrenheit's scale were so erroneous, that the numbers cannot be trusted. We have added various notes, which will be distinguished from those of the Author by affixing ED. to the former, and H to the latter.—ED.

will be of considerable importance to fix the numerical relation by which a great number of scattered observations are connected, and to reduce to empirical laws the effects of local and disturbing causes. The study of these laws will point out to travellers the problems to which they should direct their principal attention, and we may entertain the hope, that the theory of the distribution of heat will gain in extent and precision, in proportion as observations shall be more multiplied, and directed to those points which it is of most importance to illustrate.

As the phenomena of geography and of vegetables, and in general the distribution of organised beings, depend on the knowledge of the three co-ordinates of Latitude, Longitude, and Altitude, I have been occupied for many years in the exact valuation of atmospherical temperatures; but I could not reduce my own observations without a constant reference to the works of Cotte and Kirwan, the only ones which contain a great mass of meteorological observations obtained by instruments and methods of very unequal precision. Having inhabited for a long time the most elevated plains of the New Continent, I availed myself of the advantages which they present for examining the temperature of the superincumbent strata of air, not from insulated data, the results of a few excursions to the crater of a volcano, but from the collection of a great number of observations made day after day and month after month in inhabited districts. In Europe, and in all the Old World, the highest points of which the mean temperatures have been determined, are the Convent of Peissenberg in Bavaria, and the Hospice of St Gothard *. The first of these is placed at 3264, and the second at 6808 feet above the level of the sea. In America a great number of good observations have been made at Santa Fe de Begota and at Quito, at altitudes of 8,727 and 9,544 feet. The town of Huancavelica, containing 10,000 inhabitants, and possessing all the resources of modern civilisation, is situated in the Cordilleras of the southern hemi-

* The mean temperature of the air at the Convent of the Great St Bernard, the height of which is 7,960 feet, is not determined. There are several villages in Europe placed at more than 5000 feet of altitude; for example, St Jacques de Ayas at 5,479, and Trinita Nuova, near Grasfoncy, at 5,315 feet.—H.

sphere at 12,310 feet of absolute elevation; and the mine of Santa Barbara, encircled with fine edifices, and placed a league to the south of Huancavelica, is a place fit for making regular observations, at the height of 14,509 feet, which is double that of the Hospice of St Gothard.

These examples are sufficient to prove how much our knowledge of the higher regions of the atmosphere, and of the physical condition of the world in general, will increase, when the cultivation of the sciences, so long confined to the temperate zone, shall extend beyond the tropics into those vast regions, where the Spanish Americans have already devoted themselves with such zeal to the study of physics and astronomy. In order to compare with the mean heat of temperate climates, the results which M. Bonpland and I obtained in the equinoctial regions from the plains to the height of 19,292 feet, it was necessary to collect a great number of good observations made beyond the parallels of 30° and 35°. I soon perceived how vague such a comparison was, if I selected places under the meridian of the Cordilleras, or with a more eastern longitude, and I therefore undertook to examine the results contained in the most recent works. I endeavoured to find, at every 10° of latitude, but under different meridians, a small number of places whose mean temperature had been precisely ascertained, and through these, as so many fixed points, passed my *isothermal lines or lines of equal heat.* I had recourse, in so far as the materials have been made public, to those observations the results of which have been published, and I found, in the course of this easy, but long and monotonous labour, that there are many mean temperatures pointed out in meteorological tables, which, like astronomical positions, have been adopted without examination. Sometimes the results were in direct contradiction to the most recent observations, and sometimes it was impossible to discover from whence they were taken.

Many good observations were rejected, solely because the absolute height of the place where they were made was unknown. This is the case with Asia Minor, Armenia and Persia, and of almost all Asia; and while the equinoctial part alone of the New World presents already more than 500 points, the greater number of which are simple villages and hamlets, de-

termined by barometrical levelling, we are still ignorant of the height of Erzeroum, Bagdad, Aleppo, Teheran, Ispahan, Delhi and Lassa, above the level of the neighbouring seas. Notwithstanding the intimate relation in which we have lately stood with Persia and Candahar, this branch of knowledge has not made any progress in the last fifty years.

We are not authorised, however, on account of the decrease of temperature in the upper regions of the atmosphere, to confound the mean temperatures of places which are not placed on the same level. In the Old World, good observations, which can alone be used for establishing empirical laws, are confined to an extent between the parallels of 30 and 70 degrees of latitude, and the meridians of 30° east longitude, and 20° of west longitude. The extreme points of this region are the island of Madeira, Cairo, and the North Cape. It is a zone which is only a thousand nautical leagues, (1|7th of the circumference of the globe,) from east to west, and which, containing the Basin of the Mediterranean, is the centre of the primitive civilisation of Europe. The extraordinary shape of this part of the world, the interior seas and other circumstances, so necessary for developing the germ of cultivation among nations, have given to Europe a particular climate, very different from that of other regions placed under the same latitude. But as the physical sciences almost always bear the impress of the places where they began to be cultivated, we are accustomed to consider the distribution of heat observed in such a region, as the type of the laws which govern the whole globe. It is thus that, in geology, we have for a long time attempted to refer all volcanic phenomena to those of the volcanoes in Italy. In place of estimating methodically the distribution of heat, such as it exists on the surface of continents and seas, it has been usual to consider as real exceptions every thing which differs from the adopted type, or, by pursuing a method still more dangerous in investigating the laws of nature, to take the mean temperatures for every five degrees of latitude, confounding together places under different meridians. As this last method appears to exclude the influence of extraneous causes, I shall first discuss it briefly before I proceed to point out the method, essentially different, which I have followed in my researches.

The temperature of the atmosphere, and the magnetism of the globe, cannot, like those phenomena which depend on one cause, or on a single centre of action, be disengaged from the influence of disturbing circumstances, by taking the averages of many observations in which these extraneous effects are mutually destroyed. The distribution of heat, as well as the dip and variation of the needle, and the intensity of the terrestrial magnetism, depend, by their nature, on local causes, on the constitution of the soil, and on the particular disposition of the radiating surface of the globe. We must, however, guard against confounding under the name of extraneous and disturbing causes, those on which the most important phenomena, such as the distribution and the more or less rapid developement of organic life, essentially depend. Of what use would it be to have a table of magnetic dips, which, in place of being measured in parallels to the magnetic equator, should be the mean of observations made on the same degrees of terrestrial latitude, but under different meridians? Our object is to ascertain the quantity of heat which every point of the globe annually receives, and, what is of most importance to agriculture, and the good of its inhabitants, the distribution of this quantity of heat over the different parts of the year, and not that which is due to the solar action alone, to its altitude above the horizon, or to the duration of its influence, as measured by the semidiurnal arcs.

Moreover, we shall prove, that the method of means is unfit for ascertaining what belongs exclusively to the sun, (inasmuch as its rays illuminate only one point of the globe,) and what is due both to the sun and to the influence of foreign causes. Among these causes may be enumerated the mixture of the temperatures of different latitudes produced by winds;—the vicinity of seas, which are immense reservoirs of an almost invariable temperature;—the shape, the chemical nature, the colour, the radiating power and evaporation of the soil;—the direction of the chains of mountains, which act either in favouring the play of descending currents, or in affording shelter against particular winds;—the form of lands, their mass and their prolongation towards the poles;—the quantity of snow which covers them in winter, their temperature and their reflection in summer;—and, finally, the fields of ice, which form, as it were, circumpolar

continents, variable in their extent, and whose detached parts dragged away by currents modify in a sensible manner the climate of the temperate zone.

In distinguishing, as has long been done, between the *solar* and the *real climate*, we must not forget, that the local and multiplied causes which modify the action of the sun upon a single point of the globe, are themselves but secondary causes, the effects of the motion which the sun produces in the atmosphere, and which are propagated to great distances. If we consider separately (and it will be useful to do this in a discussion purely theoretical) the heat produced by the sun, the earth being supposed at rest and without an atmosphere, and the heat due to other causes regarded as disturbing ones, we shall find that this latter part of the total effect is not entirely foreign to the sun. The influence of small causes will scarcely disappear by taking the mean result of a great number of observations; for this influence is not limited to a single region. By the mobility of the aerial ocean, it is propagated from one continent to another. Every where in the regions near the polar circles, the rigours of the winters are diminished by the admixture of the columns of warm air, which, rising above the torrid zone, are carried towards the poles: Every where in the temperate zone, the frequent west winds modify the climate, by transporting the temperature of one latitude to another *. When we reflect, besides, on the extent of seas, on the form and prolongation of continents, either in the two hemispheres, or to the east and west of the meridians of Canton and of California, we shall perceive, that even if the number of observations on the mean temperature were infinite, the compensation would not take place.

It is, then, from the theory alone that we must expect to determine the distribution of heat over the globe, in so far as it depends on the immediate and instantaneous action of the sun. It does not indicate the degrees of temperature expressed by the dilatation of the mercury in a thermometer, but the ratios between the mean annual heat at the equator, at the parallel of 45°, and under the polar circle; and it determines the ratios between the solstitial and equinoctial heats in different zones. By comparing

* Raymond, *Memoire sur la Formule Baromet.* p. 108 and 113.

…lculation, not with the mean temperature drawn …tions made under different longitudes, but with …ngle point of the earth's surface, we shall set out with that which is due to the immediate action of the sun, and to the whole of the other influences, whether they are solar or local, or propagated to great distances. This comparison of theory with experience will present a great number of interesting relations.

In the year 1693, previous to the use of comparable thermometers, and to precise ideas of the mean temperature of a place, Halley laid the first foundations of a theory of the heating action of the sun under different latitudes *. He proved that these actions might compensate for the effect of the obliquity of the rays. The ratios which he points out, do not express the mean heat of the seasons, but the heat of a summer day at the equator and under the polar circle, which he finds to be as 1.834 to 2.310 †. According to Geminus ‡, Polybius among the Greeks had perceived the cause why there should be less heat at the equator than under the tropic. The idea also of a temperate zone, habitable and highly elevated in the midst of the torrid zone, was admitted by Esatosthenes, Polybius, and Strabo.

In two memoirs §, published at long intervals in 1719 and 1765, Mairan attempted to solve the problems of the solar action, by treating them in a much more extended and general manner. He compared, for the first time, the results of theory with those of observation; and as he found the difference between the heat of summer and winter much less than it ought to be by calculation, he recognised the permanent heat of the globe and the effects of radiation.

Without mistrusting the observations he employed, he conceived the strange theory of central emanations which increase the heat of the atmosphere from the equator to the pole. He supposes that these emanations decrease to the parallel of 74°, where the solar summers attain their maximum, and that they then increase from 74° to the pole. Lambert ¶, with that

* *Phil. Trans.* 1693, p. 878. † This should be 2.339.—Ed.

‡ *Isag. in Aratum*, cap. 13.; Strabo, *Geogr.* lib. ii. p. 97.

§ *Mem. de l'Acad.* 1719, p. 133; and 1765, p. 145. and 210.

¶ *Pyrometrie oder Vom Maasse des Feuers*, 1779, p. 342.

sagacity which distinguishes all his mathematical researches, has pointed out in his *Pyrometrie* the error of Mairan's theory. He might have added, that this geometer confounds the quantity of heat which a point of the globe receives under the latitude of 60° during the three months of summer, with the maximum to which the inhabitants of these northern regions see their thermometers rising in a clear day. The mean temperatures of the summers, far from decreasing from the pole to the tropics, are under the equator, under the parallel of 45°, and under that of Stockholm, Upsal, or St Petersburg, in the ratio of 81°.86; 69°.8; 61°.16 of Fahrenheit's scale. Reaumur had sent his new thermometers to the torrid zone, to Syria, and to the north. As it was then reckoned sufficient to mark the warmest days, an idea was formed of an *universal summer*, which is the same in all parts of the globe. It had been remarked, and with reason, that the extreme heats are more frequent, and even more powerful, in the temperate zone in high latitudes, than under the torrid zone. Without attending to the mean temperature of months, it was vaguely supposed, that in these northern regions the summers followed the ratio of the thermometrical extremes. This prejudice is still propagated in our own day, though it is well established, that in spite of the length of the days in the north, the mean temperatures of the warmest months at Petersburg, Paris, and the Equator, are 65°.66; 69°.44, and 82°.4. At Cairo, according to the observations of Nouet, the three months of summer are 84°.74, and consequently 19° warmer than at St Petersburg, and 15° warmer than at Paris. The summer heats of Cairo, are almost equal to those I have experienced at Cumana and La Guayra between the tropics.

With regard to the *central emanation* of the system of Mairan, or to the quantity of heat which the earth gives to the ambient air, it is easy to conceive that it cannot act in all seasons. The temperature of the globe at the depths to which we can reach, in general differs little from the mean annual temperature of the atmosphere. Its action is of great importance for the preservation of vegetables; but it does not become sensible in the air, unless where the surface of the globe is not entirely covered with snow, and during those months, whose mean temperature

is below that of the whole year. In the south of France, for example, the radiation of the earth may act upon the atmosphere in the five months which precede the month of April. We speak here of the proper heat of the globe, of that which is invariable at great depths, and not of the radiation of the surface of the globe, which takes place even at the summer solstice, and the nocturnal effects of which have furnished M. Prevost with an approximate measure of the direct action of the sun *.

Mairan had found, that in the temperate zone the heat of the solar summer is to that of the solar winter as 16 to 1. M. Prevost admits for Geneva 7 to 1. Good observations have given me for the mean temperature of the summers and the winters at Geneva 34°.7; 64°.94; and at St Petersburg 46°.94 and 62°.06. These numbers neither express ratios nor absolute quantities, but thermometrical differences considered as the total effect of the calorific influences; the ratios furnished by theory separate the solar heat from every other indirect effect. Euler was not more successful than Mairan in his theoretical essays on the solar heat. He supposes that the negative sines of the sun's altitude during the night give the measure of the nocturnal cooling, and he obtains the extraordinary result †, that under the equator the cold at midnight ought to be more rigorous than during winter, under the poles. Fortunately, this great geometer attached but little importance to this result, and to the theory from which it is deduced. The second memoir of Mairan, without adding to the problems which had been attempted since the time of Halley, has at least the advantage of containing some general views on the real distribution of heat in different continents. It is true, that the extreme temperatures are there constantly confounded with the mean temperatures; but previous to the works of Cotte and Kirwan, it was the first attempt to group the facts, and to compare the most distant climates.

Dissatisfied with the route followed by his predecessors, Lambert, in his Treatise on Pyrometry, directed his attention to two very different objects. He investigated analytical expressions for the curves, which express the variation of temperature in a

* *Du Calorique rayonnant*, p. 271. 277. 292. † *Comment. Petrop.* tom. ii. p. 98.

place where it had been observed, and he resumed in its greatest generality the theorem of solar action. He gives formulæ, from which we may find the heat of any day at all latitudes; but being perplexed with the determination of the nocturnal dispersion of the acquired heat, or the subtangents of the nocturnal cooling *, he gives tables of the distribution of heat under different parallels, and in different seasons †, which deviate so much from observation, that it would be very difficult to ascribe these deviations to the heat radiating from the globe, and to disturbing causes. We are struck with the slight difference which the theory indicates between the mean annual temperatures of places situated under the equator and the polar circle, and between the summers of the torrid zone and those of the temperate zone. It cannot be expected, indeed, that analysis is capable of determining the distribution of heat such as it exists on the surface of the globe. Without employing empirical laws, and deducing the data from actual observation, the theory can subject to calculation only a part of the total effect, or that which belongs to the immediate action of the solar rays; but after the recent successful applications of analysis to the phenomena of the radiation of surfaces, the transmission of heat through solid bodies, and the cooling of these bodies in media of variable density, we may still expect to be able to perfect the theory of solar action, and to compute the distribution of the heat received into the exterior crust of our planet.

In discussing what may be expected from the purely theoretical labours of Geometers, I have not spoken of a celebrated, but very concise Memoir of Mayer, the reformer of the Lunar Tables. This work, written in 1755, was published twenty years afterwards, in his *Opera Inedita* ‡. It is a method, and

* *Pyrometrie*, p. 141. 179. † *Id.* 318. 339.

‡ *De Variationibus Thermometri accuratius definiendis*, (*Opera inedita*, vol. i. p. 3—10.) M. Daubuisson, in a note inserted in the *Journal de Physique*, tom. lxii. p. 449. has given a formula which accords better with observation than that of Mayer. He admits that the temperature increases from the pole to the equator, as the cosine of the latitude raised to the power of $2\frac{1}{2}°$; but he judiciously adds, that this formula is applicable only to a zone of the Old World, near the Northern Atlantic Ocean.—H.

: it is an essay essentially different from those we ha ...d, and, as its learned author calls it, a determination of t... ...ean heat found empirically by the application of co-efficients furnished by observation. The method of Mayer is analogous to that which Astronomers pursue with so much success, when they correct by small steps the mean place of a planet, by means of the inequalities of its motion: It does not present the result of the solar action disengaged from the influence of foreign circumstances; but, on the contrary, it estimates the temperatures such as they are distributed over the globe, whatever be the cause of that distribution. The mean heat of two places situated under different latitudes being given, we find by a simple equation the temperature of every other parallel *. The calculations of Mayer, according to which the temperatures decrease from the equator to the poles, as the squares of the sines of the latitudes, give results sufficiently precise, when the place does not differ much in longitude from that of the regions where the empirical co-efficients have been obtained. But, even in the northern hemisphere, when we apply the formula to places situated 70° or 80° to the east or west of the meridian of Paris, the calculated results no longer agree with observation. The curve which passes through those points whose temperature is 32°, does not coincide with any terrestrial parallel. If, in the Scandinavian Peninsula, we meet with this curve under the 65th or 68th de-

* The formula given by Mayer was $T = 24 \cos^2$ Lat.; or $T = 12 + 12 \cos 2$ Lat. for Reaumur's scale; and $T = 84 - 52 \sin^2$ Lat., or $T = 58 + 26 \cos 2$ Lat. for Fahrenheit's scale. Since the publication of Humboldt's memoir, M. Daubuisson has resumed the subject of the earth's temperature in his *Traité de Geognosie*, tom. i. p. 424. Paris, 1819. He gives the following formula, which is almost the same as that of Mayer, for finding the mean temperature, according to the Centigrade scale, viz. $T = 27° \cos^2$ Latitude. This formula, which is superior in accuracy to Mayer's, gives all the temperatures in *defect* for latitudes below 42°, and in *excess* for all the higher latitudes, as appears from Daubuisson's table. It is therefore obviously defective. M. Daubuisson, however, considers it as applicable principally between the parallels of 30° and 60° of N. lat. It ought to be remarked, that in the above formula, 27° has been *assumed as the mean temperature* of the equator, in order to make the results agree with observations made in the temperate regions, whereas the mean temperature of the equator, as ascertained by Humboldt, is 27°.5; and if this were used in Daubuisson's formula, it would make the differences still more in excess.— Ed.

gree of latitude, it descends, on the contrary, in North America, and Eastern Asia, to the parallel of from 53° to 58°. But the direction and the inflexions of this curve of 32° of temperature influences the neighbouring isothermal lines in the same manner as the inflexions of the magnetic equator modify the lines of inclination. To demand what is the mean temperature, or what is the magnetic inclination under a particular degree of latitude, is to propose problems equally indeterminate. Though, even in high latitudes the magnetic and the isothermal lines are not rigorously parallel to the magnetic equator, and to the curve of 32° of temperature; yet it is the distance of any place from this curve which determines the mean temperature, as the inclination of the needle depends on the magnetic latitude.

These considerations are sufficient to prove, that the empirical formulæ of Mayer require the introduction of a co-efficient, which depends upon the longitude, and consequently on the direction of the isothermal lines and their nodes with the terrestrial parallels. Mayer had no intention of disengaging the results which he obtained from the influence of all disturbing causes: He limited himself to the determination of the effects of altitude above the level of the sea, and those of the seasons, and the length of the day. He wished to point out the way which philosophers ought to pursue in imitating the method of astronomers. His Memoir was written at a time when we did not know the mean temperature of three points on the globe; and the corrections which I propose after tracing the isothermal lines, so far from being incompatible with the method of Mayer, are, on the contrary, among the number of those which this geometer seems to have indistinctly foreseen.

Kirwan, in his work on Climates, and in a learned Meteorological Memoir, inserted in the eighth volume of the Memoirs of the Irish Academy, attempted at first to pursue the method proposed by Mayer, but, richer in observations than his predecessors, he soon perceived, that after long calculations, the results agreed ill with observation *. In order to try a new method, he selected, in the vast extent of sea, those places

* Kirwan's *Estimate of the Temperature of the Globe*, chap. iii.

perature suffered no change but from permanent causes. These were in the part of the great ocean commonly called the Pacific Ocean, from 40° of South to 45° of North latitude, and in the part of the Atlantic Ocean, between the parallels of 45° and 80°, from the coasts of England to the Gulf Stream, the high temperature of which was first determined by Sir Charles Blagden. Kirwan tried to determine for every month the mean temperature of these seas at different degrees of latitude; and these results afforded him terms of comparison with the mean temperatures observed on the solid part of the terrestrial globe. It is easy to conceive, that this method has no other object, but to distinguish in climates that is in the total effect of *calorific influences*, that which is due to the immediate action of the sun on a single point of the globe. Kirwan first considers the earth as uniformly covered with a thick stratum of water, and he then compares the temperatures of this water at different latitudes, with observations, at the surface of continents indented with mountains, and unequally prolonged towards the poles.

This interesting investigation may enable us to appreciate the influence of local causes, and the effect which arises from the position of seas, on account of the unequal capacity of water and earth for absorbing heat. It is even better fitted for this object than the *Method of Means* deduced from a great number of observations made under different meridians; but in the actual state of our physical knowledge, the method proposed by Kirwan cannot be followed. A small number of observations made far from the coasts, in the course of a month, fixes, without doubt, the mean annual temperature of the sea at its surface, and, on account of the slowness with which a great mass of water follows the changes of the temperature of the surrounding air, the extent of variations in the course of a month is smaller in the ocean than in the atmosphere: But it is still greatly to be desired *, that we should be able to indicate by direct experience, for every parallel, and for every month, the mean temperature of the ocean under the temperate zone. The scheme which Kirwan has formed for the extent of the seas, that ought to

* See my *Relation Historique*, tom. i.

form the term of comparison, is founded only in a small degree upon the observations of navigators, and to a great degree on the theory of Mayer. He has also confounded experiments made on the superficial temperature of the ocean with the results of meteorological journals, or the indications of the temperature of the air which rests upon the sea: He has obviously reasoned in a circle, when he modified, either by theoretical suppositions or by observations made on the air upon the coasts of continents, the table of the temperature of the ocean, in order to compare afterwards with these same results, partly hypothetical, those which observation alone furnished in the interior of the earth. After the works of Kirwan, we must notice those of Cotte, which are merely laborious, though useful, compilations, which, however, ought not to be used without much circumspection. A critical spirit has rarely presided over the reduction of the observations, and they are not arranged so as to lead to general results.

In detailing the actual state of our knowledge on the distribution of heat, I have shewn how dangerous it is to confound the results of observation with theoretical deductions. The heat of any point of the globe depends on the obliquity of the sun's rays, and the continuance of their action, on the height of the place, on the internal heat and radiation of the earth in the middle of a medium of variable temperature; and, in short, upon all those causes which are themselves the effects of the rotation of the earth, and the inequal arrangement of continents and seas. Before laying the foundation of a system, we must group the facts, fix the numerical ratios, and, as I have already pointed out, submit the phenomena of heat, as Halley did those of terrestrial magnetism, to empirical laws. In following this method, I have first considered whether the method employed by meteorologists for deducing the mean temperature of the year, the month and the day, is subject to sensible errors. Assured of the accuracy of the numerical averages, I have traced upon a map the isothermal lines, analogous to the magnetic lines of dip and variation. I have considered them at the surface of the earth in a horizontal plane, and on the declivity of mountains in a vertical plane. I have examined

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PHILOSOPHICAL JOURNAL.

Biographical Memoir of Sir William Herschel. By Baron Fourier *.

The illustrious individual, with an account of whose life I am about to present you, was one of those extraordinary men who, although destined to honour their country and their age, have at their outset had to surmount all the obstacles which an adverse fortune presents to the first efforts of genius. He opened up new paths in a sublime science; he saw stars whose existence was previously unknown, and extended the boundaries of the visible heavens. Supported by the liberality of a powerful monarch, he devoted his life to immortal labours, and, for forty years, the fame of his discoveries has echoed through all Europe.

At the age of nineteen he was only a musician in the Hanoverian Guards. His father, who had a numerous family to support, was an able teacher of music, and educated five of his children in his own profession. William, his second son, who was possessed of a lively imagination and elevated mind, left his native city Hanover in 1757, and went over to England, where the state of society held out to him the prospect of a better fate.

He resided some years in the county of Durham, then at Halifax, and soon after was appointed director of music to the

* Read to the Royal Academy of Sciences of the Institute of France, at the 7th June 1824.

Octagon Chapel at Bath. In this situation he enjoyed a considerable income, arising partly from his office, and partly, also, from his directing public concerts and oratorios.

His talents were admired, his character beloved, and his manners esteemed; and, in a country where the fine arts are duly appreciated, if the common advantages of fortune had been his only object of ambition, his desires would have all been satisfied; but an internal power impelled him to higher destinies,—he was one day to extend the empire of science.

The profound study of his art led him by degrees to that of geometry; for there exist numerous relations between the laws of harmony and the theorems of mathematics, as has been proved by many illustrious geometricians, from Pythagoras and Euclid to Descartes, Huygens and Euler.

Herschel, introduced by geometry to the knowledge of theoretical astronomy, was seized with astonishment and admiration, and felt as if transported into a new world. He anxiously desired to contemplate for himself those celestial phenomena whose laws the human intellect had been able to discover. It was then that he began to construct telescopes, and undertook to improve their use; and as perseverance in his resolutions was always the distinguishing character of his mind, he accomplished these objects, and soon found himself possessed of instruments superior to all that an art so difficult and ingenious had yet produced. His first astronomical observations, which bear the date of 1776, were followed by a memorable discovery which excited the public attention to the highest degree,—I mean that of the planet which for several years has borne the name of Herschel.

The earliest observers of the heavens distinguished a small number of stars, which are continually changing their position with regard to the fixed stars, and return periodically to the same points of the sphere. The different durations of these revolutions of the planets were known and compared with each other from time immemorial, and to them is owing the period of seven days, the universal monument of the astronomy of the ancient nations. The moderns had made wonderful advances in the description and study of the heavens. Galileo, Huygens, and Dominique Cassini, had observed the first of the secondary stars

which the planets carry along with them in their course; but it was not discovered, till the close of the last century, that there existed an immense planet beyond the orbit of Saturn. This discovery was destined to be the fruit of Herschel's labours. He pursued with constancy the enterprise which he had formed of examining successively the various regions of the heavens, and of noting down all the remarkable phenomena which occurred. At Bath, on the 13th March 1781, while examining, with one of his best telescopes, the constellation of Gemini, he observed a star, the light of which appeared to him very different from that of the neighbouring stars, and somewhat to resemble that of Saturn, but much feebler. The perfection of the instrument permitted him to see a well defined disk. Having continued his observations, he discovered that this star had shifted its place, although its motion with relation to the other stars was very slow, for it had been stationary during twelve days preceding. This observation was transmitted to Maskelyne and Lalande, and was confirmed at Paris, Milan, Pisa, Berlin, and Stockholm. The star was generally considered as an extraordinary comet free of all nebulosity; and astronomers were occupied in determining the parabolic elements of its course. The President Bochard de Saron, of the Academy of Sciences of Paris, and Lexel, an astronomer of St Petersburg, who was in London at the time, were the first who discovered its circular form, and calculated the dimensions of the orbit. It was now no longer doubted, that Herschel's star was a new planet; and all subsequent observations verified this unexpected result. We have here a striking proof of the perfection of modern theories; for the laws regulating the motion of this new planet, were determined before it had accomplished the tenth part of its course, and that motion was not less accurately known than that of other planets which had been observed during so many centuries. Its distance from the sun is double that of Saturn, that is to say, upwards of 660,000,000 of miles; its volume is more than seventy times as large as that of the earth; it may be seen, in favourable weather, without the assistance of a glass. The period of its revolution is about eighty-four years; and its temperature, situated at the extremities of the known planetary system, is more than forty degrees below that of ice. Some idea

of its distance from the earth may be formed from the fact, that light, which travels at the rate of 70,060 miles in a second, takes about two hours and a half to come from it to us.

Herschel, and, previous to his time, Dominique Cassini and Galileo, wished to give to the celestial bodies which they discovered, the names of the princes who had favoured their labours; several astronomers have proposed the names of the first observers; but the names of the recently discovered planets have not been dictated either by justice or gratitude; they have been drawn from the confused remembrance of fables that have become unintelligible. The new planet received from Herschel the name of the Georgium Sidus; while astronomers at first gave it that of Herschel, but afterwards hesitated with regard to the names of Cybele, Neptune, and Uranus, the last of which ultimately prevailed.

When the motion of this planet was calculated, the points of the heavens which it had successively occupied during the preceding century, could be pointed out; and thus, on consulting the collections of preceding observations, it was discovered that Flamsteed, Mayer, and Lemonier, had pointed out, in those very places, stars which are now no longer to be seen there. Their observations evidently refer to Herschel's planet, which they had not distinguished from the fixed stars.

The cosmological opinions of Kepler, Lambert, and Kant, led them to suppose the existence of an eighth planet between Jupiter and Mars. The comparison that had been made of the distances of each planet from that of Mercury, which is the nearest to the sun, suggested a similar remark. The discovery of Uranus rendered the idea much more plausible, and excited astronomers to new researches. The result was, that, in the great interval between Mars and Jupiter, and at a distance differing little from what had been indicated, there were discovered four small stars, which look like so many separated parts of the same planetary body, and which can only be perceived with the aid of telescopes. These important observations were made about the commencement of the present century; we owe them to Piazzi, Olbers, and Harding.

The astronomical labours of the music master of the Bath Chapel, the perfection of his instruments, which were all his own

workmanship, the singular circumstances of his life, the aids with which the arts had furnished him, and the noble use to which he applied his leisure hours, were the subject of conversation in England, and throughout all Europe. All these details came to the knowledge of the king. George the Third loved the sciences as the ornament of states, and as a pure source of glory and public prosperity. He sent for Herschel, anticipated and realized all his views, and made him fix his residence at Datchett, and soon after at Slough, within a very short distance of Windsor Castle.

The retreat of Slough became one of the most remarkable places of the civilised world; it was visited by illustrious travellers, Herschel dwelt there with his family; it was there that he finished his long and memorable career. The king interested himself in all his researches, and frequently wished to augment the expences proposed, in order that nothing might limit either the perfection or the dimension of his instruments. History ought to preserve for ever the reply of this prince to a celebrated foreigner who was thanking him for the large sums he had expended in furthering the progress of astronomy. "I pay the expences of war," said the king, "because they are necessary; as to those of science, it is agreeable to me to prescribe them; their object costs no tears, and does honour to human nature."

Herschel had secured the assistance of one of his brothers, a man well skilled in theoretical and practical mechanics, who seconded all his designs, directed the carpenters in the construction of the large instruments, and, with a rare sagacity, realized, almost as soon as expressed, all his brother's inventions. Their sister, Miss Caroline, soon acquired a very extensive knowledge in astronomy and mathematics. A lively and constant friendship, the desire of contributing to the glory of her brother, and without doubt a disposition of mind peculiar to this extraordinary family, procured her unrivalled success in her studies. She digested and published his observations. We are also indebted to her for the discovery of several comets. She participated in all the watchings, and in all the literary labours of her brother; and assuredly no astronomer ever had a more intelligent, more faithful, and more attentive assistant.

In this secluded retreat, adorned by the fine arts, and still

more by peace and the domestic virtues, Herschel, free from all cares, surrounded by a beloved wife and family, devoted to science, surrendered himself to the inspirations of his genius, or, in other words, to an invincible desire of studying nature and interrogating the heavens; and, to borrow the words of one of his most celebrated cotemporaries, it was from this solitary village that the world was instructed in whatever was most singular, and, perhaps, most difficult to perceive in the heavens.

The history of optical inventions, and of their progressive improvement, is too well known to require any notice in this place. Herschel's telescopes are those that have been named Newtonian. But he never ceased to study their properties, to vary them, and extend their use. Taught by long experience, he suppressed the plain mirror which produced a second reflection; and this happy change, which was long before proposed by Lemaire, but difficult of execution, and only applicable in large instruments, doubled, in a manner, the optical effect.

He found, that, by exercising the eye in a gradual manner, it is rendered much more sensible to the impression of a weak light, and by this means he was enabled to magnify the images of objects much beyond the limits at which other observers had been arrested. He detected two different properties which had not yet been distinguished, that which consists in augmenting the apparent dimension of bodies, and that of penetrating into the profundity of space to discover objects which might have been entirely imperceptible. Multiplied examples leave no doubt regarding the truth and striking utility of this distinction.

At length he formed the resolution of carrying the power of these instruments to the highest possible limits; regarding less the circumstances calculated to facilitate their employment, than those which might augment their optical power, he constructed a telescope of extraordinary dimensions. It is indeed the largest instrument of this kind that has ever been made.

Let any one imagine to himself an iron tube, 40 feet long and 15 inches in diameter, suspended beneath an assemblage of inclined masts, and moved in all directions by a number of machines. The entire system is moveable round a vertical axis, and describes a circumference of 40 feet diameter. A highly polished metallic mirror, weighing about 2000 pounds, is introduced in-

to the tube, and when the instrument is turned toward the heavens, this mirror reflects the shining image of the stars. The observer is himself transported along with the tube in any direction required, for he is placed in a seat attached to the upper extremity; the objects which he observes are behind him, and he views their reflected images.

Herschel discovered, with this telescope, two new satellites of Saturn; they are both nearer the planet than those made known by Huygens and Cassini. Never had the heavens been observed with so extraordinary an instrument; and, it may be said, that the greatest phenomena displayed themselves under a novel aspect. The nebulosities, those small luminous and irregular clouds which may be remarked among the fixed stars, in various regions of the heavens, appeared almost all to resolve themselves into an innumerable multitude of stars; others, hitherto imperceptible, seemed to have acquired a distinct light. On the entrance of Sirius into the field of the telescope, the eye was so violently affected, that stars of less magnitude could not immediately after be perceived; and it was necessary to wait for twenty minutes before these stars could be observed.

The instruments, of which he had previously made use, were less advantageous for the observation of some phenomena; but it was more easy for him to multiply them, and vary their modes of application. No astronomer had yet been able to acquire so complete and so distinct a knowledge of the phenomena of the heavens. For example, the ring of Saturn always ceased to be perceived when its plane was directed toward the earth; but the feeble light which it reflects in that position was enough for Herschel, and the ring still remained visible to him.

An entirely new and very important observation made by him, was that of certain remarkable points on the surface of Saturn's ring. From these points, Herschel concluded, that this satellite, remarkable for its singular form, turns upon itself round an axis perpendicular to its plane; and he measured the duration of this rotatory motion, which is about ten hours and a-half.

Not long before, a great geometrician in France investigated the same question, and solved it by mathematical analysis, which is also a very powerful instrument, and the most general of all. M. de Laplace demonstrated, that the rotation of the ring of Sa-

turn is a necessary consequence of the general principle of gravitation. He deduced from his analysis the same duration of ten hours and a-half, which the English astronomer afterwards found by direct observation. The history of science presents nothing more worthy of the attention of philosophers than this wonderful accordance of theoretical inductions with the improvement of the arts.

Herschel's observations are so numerous and so varied, that we cannot here attempt any exposition of their subjects. Most of them have been confirmed and reduced to perfect certainty The instruments which he used, and which possess so many remarkable advantages, are, however, liable to difficulties which limit their utility. His largest telescopes ought always to be considered rather as instruments of discovery than as instruments of precise measurement In this respect they are among the most perfect productions of human ingenuity.

We shall now speak of Herschel's views and experiments relative to the physical properties of the solar rays From a long series of observations, made with powerful telescopes, he concluded that the light does not emanate from the body of the sun, but from certain shining and phosphoric clouds, which are produced and developed in its atmosphere. He thought that this immense ocean of light is violently agitated in its whole depth; that, when it is broken up, we perceive either the solid mass which is not so luminous, or its volcanic cavities, and that this is the origin of those black and variable spots which are seen on the sun's disk. Their extent is often much greater than the whole surface of the terrestrial globe; they disappear when a calm is re-established in the solar atmosphere. It is well known that these spots, first observed by Galileo, led to the discovery of the sun's motion around its axis, and shewed that this motion is accomplished in twenty-five days and a-half.

The new improvements in optics afford a very unexpected means of determining, whether it be true, as Herschel imagined, that the solar light does not issue from an incandescent solid or fluid. In fact, when such a body, raised to a very high temperature, becomes luminous, the rays which it gives off in all directions do not come from the outer surface only, but are also emitted like the rays of heat by a multitude of material points

placed beneath the surface to a certain depth, extremely small it is true, but actually existing. Now, such of these rays as traverse the envelope of the heated mass obliquely, acquire and preserve a peculiar property which can be rendered sensible by experiment; they are polarized. But if the same mass, instead of being rendered luminous by its proper temperature, is only covered with an extended flame, which is the source of its light, the rays then do not possess this property.

We have, therefore, been enabled to submit to this singular test the light which the sun sends to us. M. Arago, the author of this beautiful experiment, and by whose labours natural philosophy and astronomy have often been enriched, has in fact discovered, that the solar rays, even when transmitted obliquely, are not polarized. It is therefore obvious, that, in regard to this point of the question, the opinion proposed by Herschel would be immediately deduced from the latest discovered properties of light. His researches, also, regarding the annual variations of the solar heat have excited the attention of philosophers; and we shall soon be in possession of more accurate information on this subject. In several countries, and especially at the Royal Observatory of France, it has been resolved to collect and to publish every year accurate observations with respect to the extent, the progress, and disappearance of the solar spots.

We have now to mention the memorable experiments of Herschel, which have given a new development to the physical theory of the sun's rays. In studying the nature of that star, which had become with him a habitual subject of meditation, he employed variously coloured glasses for diminishing the intensity of the light. He thus had numerous opportunities of observing to what degree the interposition of these glasses modified the heat or light. It was not in the nature of his mind to stop at superficial remarks. He therefore undertook a series of varied experiments, and general physics was enriched with new and important facts, which have been fully confirmed by subsequent observations. It had long been discovered that the rays separated by the prism, and forming the solar spectrum, do not possess the faculty of heating the terrestrial bodies to the same degree. This opinion had been verified by experiments made in Italy and France.

In tracing the origin of this question, we find it in the writings of a celebrated woman, whose name belongs to the literary history of France. Emiliè du Châtelet, previously to her translating and commenting upon the works of Newton, had sent a physical memoir to the Academy of Sciences at Paris, and afterwards embarked with Euler in the examination of one of the greatest objects of natural philosophy, the theory of fire. In this memoir of Madame du Châtelet's, which was printed in 1738 by order of the Academy, the illustrious author proposes to collect a sufficient quantity of homogeneous light to prove whether the differently coloured primitive rays have not also unequal degrees of heat; whether, as appears to her to be very probable, the red ray, for example, does not give more heat than the violet ray. The writer adds, "the experiment deserves to be tried by those philosophers who may examine this essay." The idea here expressed was proved correct, as we have said, by the observations of Landriani and Rochon. Herschel's experiments on the same subject not only afforded a complete solution of the question, but led to entirely new results. He measured with precision the thermometrical effects of the seven unequally refrangible rays, and found that the red rays contained of themselves more heat than all the others together. The impression on the thermometer rapidly diminishes from the red to the violet rays, which are placed at the other extremity. The principal feature of Herschel's talent was an extraordinary disposition to consider the same object with unremitting perseverance, and under every point of view. On repeating his experiments on the solar rays, he wished to determine the limit at which all sensible impression of heat ceases, and the point at which the impression is strongest. While engaged in this investigation, he met with a very unexpected result; he saw that the thermometrical effect continues beyond the red rays in the dark space bordering upon the spectrum, and it was even in that unilluminated space, and upon the prolongation of the axis, that he found the point where the heat communicated is the greatest. The situation of this point is found to vary according to the circumstances of the experiment; but, be this as it may, it is certain that this mixture of rays which the same star transmits to us, and which the prism re-

fracts unequally, and divides into coloured elements, contains, also, an invisible heat, whose action may be rendered sensible and may be measured.

The same observer further proposed to himself, to discover what are the rays which possess the power of illuminating bodies in the highest degree. He found, by a particular set of experiments, that this property belongs to the yellow rays, and that it diminishes with considerable rapidity, as we pass from these rays to either extremity of the spectrum.

These singular discoveries excited a lively interest in all the learned societies. The existence of an invisible radiating heat, mingled with the solar light, was disputed. The discoverer was himself exposed to contradictions which exceeded all the bounds of literary criticism; but that great philosopher having given the necessary explanations, kept silence on the subject. His experiments were repeated in England, Germany, and France, under the eyes of the most expert observers in Europe, and the truth of the results was universally recognised.

It happened, also, that the distinction of the coloured rays, and of the invisible heat which the sun transmits, gave rise to the discovery of another not less remarkable property of the light of that star. The intensity of the chemical action of the different rays was made the subject of observation, and it was found that this action also, like that of the heat, subsists in an unilluminated space, but at the opposite extremity of the spectrum beyond the violet rays. We merely mention this experiment, as it does not properly belong to our subject; and it is enough for us to add, that, at the present day, the existence of invisible rays of heat mingled with the sun's light, can no longer be questioned. It was chiefly in this that the discovery announced by Herschel consisted. It seemed as if he were destined to discover and render sensible objects and properties, which had eluded the research of all other observers for a long series of ages.

Although our planetary system occupies an extent of twelve hundred millions of miles, it may yet be said to form but an imperceptible point in the immensity of space. Thus far has the genius of man enabled him to penetrate into the vast regions of the universe. He has seen innumerable suns beyond the natural limits of his senses; for the divine intellect from which his

reason emanates, has given him the power of forming, as it were, new organs for himself. From time immemorial, sensible changes have been observed in the colour and brightness of several stars; new stars have been seen all of a sudden bursting forth into brilliancy, and, like ignited bodies, gradually fading and disappearing, having, perhaps, been converted into unilluminated orbs, and for ever withdrawn from our view. The proper and always extremely slow motions of a pretty large number of stars have been observed, or the alternating and periodical variations of some of these bodies. A more perfect knowledge of the history of the heavens is without doubt reserved for the generations to come. We can only, at present, hope for fixed and accurate results, like those of planetary astronomy, we are confined to the description of the present state, and the distinction of the general characters of phenomena. The invention of telescopes, and especially Herschel's observations, have given a prodigious extension to this branch of celestial physics.

We shall not here enumerate all the cosmological views of this great astronomer. The exposition of so extensive a theory would exceed the limits assigned to us; but we shall point out some of its principal features. He ranks in the first class the stars which he names isolated, that is, such as are separated from the others by immense intervals, and do not appear subject to a mutual action, whose effect is appreciable. He then considers the double or triple stars, or the more complex sideral assemblages, which are systems of luminous bodies, evidently approximated and retained by an existing cause, and move together round a common axis.

He next passes to the description of the nebulosities, or those milky-looking and confused spots irregularly scattered throughout the heavens. He chiefly observed the Milky Way, which he considered as a single nebulosity formed of many millions of stars. In it he saw more than fifty thousand traverse the field of his telescope in an hour. All these stars are distributed in a multitude of layers of great extent, in length and breadth, and so superimposed, that the thickness of the system is much smaller than the other two dimensions. The stars which appear to us to be the brightest belong to the Milky Way. This is also the case with the sun, the centre of our planetary orbits, and it

is for this reason, that, being placed in the interior of this nebulosity, we see it as a zone which divides and surrounds the heavens. The first origin of these views occurs, if I mistake not, in the writings of Kant, and afterwards in those of Lambert, one of the most celebrated geometricians of Germany. But Herschel, to whom these works were unknown, did not confine himself to general considerations. He deduced from positive and multiplied observations that explanation, which had been entertained by the celebrated philosopher of Kœnigsberg, and the academician of Berlin.

He distinguishes among the nebulosities those which powerful telescopes resolve into a multitude of separate stars, those in which one or more shining centres are observed, and those which he names planetary, of a more defined spherical form, and a more homogeneous lustre. He shews the singular variety of this order of phenomena, most of which were before unknown. His catalogues contain more than two thousand nebulosities, some resembling the Milky-Way, others open in the middle, and of an annular figure, but the greater part under the most diversified and irregular forms. Lastly, He added a multitude of observations to those that had already been made on the stars which are coloured red, blue or green, or which present shades of these colours, and principally on the double or multiple stars.

If one now considers the whole of these facts together, he naturally rises to the idea of a rare and diffuse luminous matter, of which all the celestial bodies have been formed. This matter, diffused over every part of the universe, is very unequally condensed there. It is still in the state of vapour in many nebulosities, and in the atmospheres of the comets, which are so extended and so variable. The principle of gravitation does not act on the bodies of the planetary system alone; it is present in all points of space, and always opposed to the expansive force of heat. It is conceived that universal attraction may have gradually united these luminous vapours; that the shining centres, whether single or multiple, the groupes of stars, and the solid bodies, are formed of them. These effects are not equally sensible in the different stars; they are much advanced in some, very weak in others, and tend to manifest themselves more and

more. Lastly, the same causes keep up among all these bodies immense motions, which their extreme distance scarcely permits us to distinguish.

Such, in so far as it is possible to express them in a few words, are the cosmogonic views of Herschel. The illustrious author of the Mécanique Céleste has arrived at similar inferences, by following a path directly the reverse. He has seen in our system of planets and satellites, striking indications of the origin of these bodies. He considers them as formed at the limits of the sun's atmosphere, gradually condensed by the attractive forces, and the loss of radiant heat. Thus all the fundamental circumstances of the planetary system are naturally explained. There is no opinion more in conformity with the present state of science; it accounts for all the phenomena known.

The celestial bodies, therefore, which are least distant from us, present, with great precision, the general characters which they retain of their origin; they appear to have been produced, like all the great phenomena of the Heavens, in the bosom of those luminous vapours subjected to the two contrary actions of gravitation and heat.

I shall not undertake, gentlemen, to fix your attention to the various parts of this vast picture, to compare the distances of these stars from those which we are able to measure, to compute the years that must have elapsed before their light reached us. Here the numbers, the times, and the spaces, want limits; the most comprehensive mind is unable to form a conception of the immensity of the universe; it only attains it by rising to thoughts of an order still more sublime. This reflection brings us back to the sentiments which Herschel has frequently expressed, and which the contemplation of the wonders of the Heavens constantly forced upon him. In each of the great phenomena which he observed, he found the impress of an eternal and creative wisdom, which rules, animates, and preserves, and which has given immutable laws to all nature.

Let one now represent to himself the picture of an entire life devoted to the fine arts, and to the description of the Heavens. In the early period of his life Herschel struggled against fortune

and subdued her. His glory was increased by all that the chance of birth had refused him.

The arts introduced him to the sanctuary of the sciences; he improved optics; he undertook to describe the natural history of the heavens; he saw new stars at the extremities of the planetary world, the extent of which he doubled.

He contemplated innumerable phenomena in regions where the eye of man had never before penetrated; he studied the nature of the sun, divided its rays, measured their brightness, separated light from heat; he saw the effects of gravitation in all the depths of space. To no man was it given to make known to others so great a number of new stars. Whatever the universe displays of what is immense and imperishable, was the habitual object of his contemplation. Such were the occupations of his mind; let us now notice the sentiments with which they inspired him.

He lived in the heart of a nation which, above all others, regards the glory of its great men as public property. He enjoyed pure happiness in the bosom of his family; his prayers were answered by the success of his son, and he heard the public voice repeating the just and soothing expression, which may here be applied to so many others, Herschel leaves a son worthy of his father. A benevolent prince had wished to be acquainted with him, and from that moment declared himself his protector and friend. His sister Caroline Herschel, an admirable model of disinterestedness, gentleness and perseverance, devoted her life to him. For more than forty years she assisted at all his watchings, collected all his thoughts, transcribed with her own hand, and published all his works; nor could she permit any other to have this charge committed to him. She wrote and preserved those immense registers which Herschel left to his son, in which are faithfully deposited from the year 1776 all his observations and experiments,—a truly noble and glorious inheritance, which is at once the monument of a sublime science, and of the most affecting friendship.

Astronomy and physics will long find in these records a fertile source of comparisons and discoveries. Thus the influence of great men stretches forth into futurity; and it is not at their death that all the fruits of their labours can be appreciated.

The physical picture of the heavens traced by Herschel, will be compared with recent observations, and the changes will be remarked which a long interval may have produced. Already striking consequences present themselves to the mind, but time alone can develope them; and they will only become manifest after a great number of ages.

Then entire revolutions will be accomplished, our successors will admire other phenomena and other stars; a part of the spectacle of the Heavens will be changed; but at those remote epochs the memory of Herschel will still be fresh.

He died in the eighty-fourth year of his age, without infirmities and without pain. His name, confided to the grateful sciences, is for ever preserved from oblivion,—they crown it with immortal glory.

Description of a New Magnetical Instrument (proposed to be called the Solar Compass or Heliastron), with some Observations on subjects intimately or remotely connected with the phenomena it exhibits. By MARK WATT, Esq. Member of the Wernerian Natural History Society. Communicated by the Author *.

THE effect of the sun upon the earth, and on all the animate and inanimate existences that it contains, has seldom or never been over-rated, but, perhaps, hitherto, has been in many minor instances under-rated, or entirely overlooked. It is long, indeed, since the grand influence the sun exerts on the planetary system, and the general and striking changes it produces upon the world, observable in the seasons, the tides, the trade-winds, the diurnal revolutions, &c. have been made objects of investigation and calculation, whilst its less ostensible, though, perhaps, not less important impulses on animal organisation, plants, chemical changes, and delicately formed instruments for meteorological observations, have been comparatively the subjects of modern research.

* Read before the Wernerian Natural History Society, 24th November 1827.

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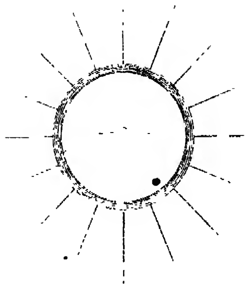


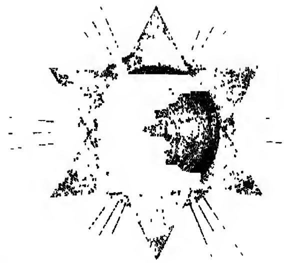


Fig 2

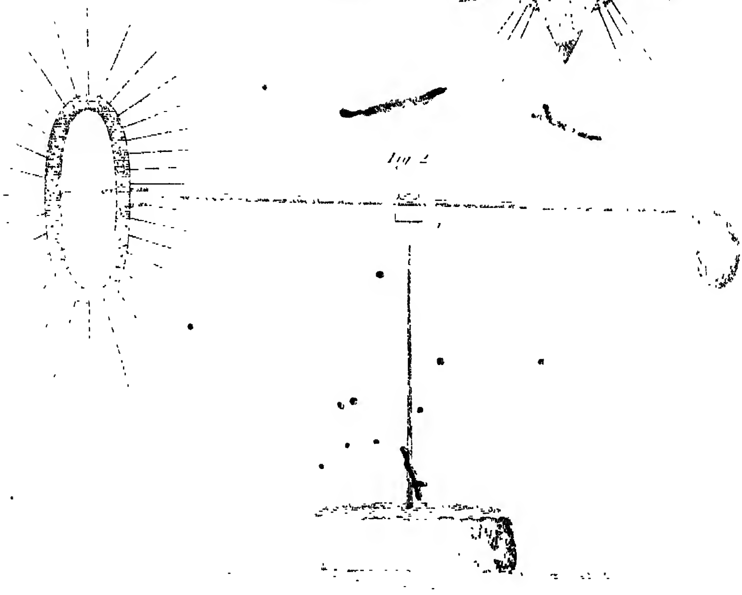
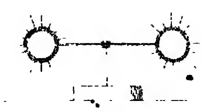


Fig 3



[illegible] Compass

From observing, in particular, the daily variation of the barometer and the magnetic needle, and remarking that a similar series of alternate changes was more or less observable in every instrument capable of indicating a slight alteration in the impressions made on them, as the hygrometer, æthrioscope, photometer, &c.; and that these diurnal changes bore a proportionate relation to the latitude in which the instruments were placed, or to the degrees of solar influence that might exist in the regions in which they were used, and of which they would partake; and from noticing, in coincidence with these movements, the daily expansion and contraction of the petals and leaves of most plants, and that the different species of the heliotropium and chrysanthemum turned their corollæ round toward the sun for many hours during the day, when the atmosphere was clear, I could not help concluding, for a long time past, that what was thus partially exhibited by some instruments, and more perfectly by the corollæ of plants, might be still more clearly shewn, by an instrument constructed upon principles nearly similar to the laws which regulate the motions in plants, and that one might be formed, that would, when suspended, move to the sun's apparent course, or that would, from the attracting or repelling influence of the solar rays, stand still, in opposition to the diurnal revolution of the earth.

Having an opportunity, last spring, of making some simple experiments in pursuit of what had become with me rather a plausible idea, I commenced, by attempting to trace the general connection that appears to subsist between the solar rays, electricity, magnetism, and the radiation of caloric, in as far as they had any reference to the object I had in view; to mark their natural effect on plants, and to observe if metals, or other substances, when placed in favourable circumstances, were not susceptible of similar impressions from these general agents, at least so far as to indicate by their motion when suspended, the same attraction or repulsion, in respect to the sun's influence that the daily alterations in the positions of the corollæ of plants evinced.

In the course of those investigations, I observed, amongst other things, (which it would be unnecessary here to detail,

that the leaves, petals, and stamina of all plants, were, when growing, strongly attracted by any good electric, when it was rubbed; and that, particularly, when any of the precious stones that were transparent, were rubbed and presented to the leaves or petals of plants, that they sprung to it, and stuck to it, as a piece of iron to the magnet, and they remained attached to it as long as the electricity was retained by the stones *; sometimes half a minute.

I also found, that all electrics attracted the magnetic needle in proportion to their powers of retention, and that, consequently, the magnet attracted all electrics when charged with electricity; and that all feathers of birds, hairs of animals, and pistils, petals, and stamina of plants, were strongly attracted by electrics; and when in contact with any body that retained electricity, were more or less attracted by the magnet; and that, therefore, they might all be considered, in a certain sense, natural magnets, -being all attracted to, or attracting, light, caloric, electricity, and the magnetic fluid.

In illustration of these observations, I would mention, that when a piece of wax or amber is rubbed, it attracts the compass needle. A Brazilian topaz will attract the magnetic needle if only once or twice passed over a piece of woollen cloth. If rubbed a few seconds, it makes the needle move round on its pivot, in the same manner as a magnet would. The topaz, amethyst, and sapphire, also, when rendered electrical by friction, suspend small pieces of iron or steel. A topaz of an inch square will suspend six common sewing needles horizontally, for an hour or two; and if this is frequently repeated, the stone being rubbed for half a minute or so each time, the needles acquire the magnetic property; and if they are placed gently on the surface of water, so as to swim, they will all arrange themselves parallel to the magnetic meridian; this polarity they seem to lose in a day or two.

If a piece of clear amber, of an oblong shape, be subjected to rapid friction for half a minute, it will, when made to swim on

* The conducting power of living plants, in favouring the rapid distribution of electricity, has been reckoned three millions of times greater than that of water. I should conceive from this fact, that the conducting power of living plants was too highly rated.

still water, indicate polarity, by pointing according to the magnetic meridian. Feathers, hair, and the pistils of large plants, as the digitalis and antirrhinum, appeared to me, when treated in the same way as the needles, to indicate a similar disposition. If the downy part of feathers, fine hair, or the large thistle down, is laid upon an electric, after friction, the parts that project beyond the sides of the electric, are considerably attracted by the magnet.

All electrics evince polarity, and those that have the power of retaining electricity long, demonstrate this, by pointing north and south, if formed into an oblong, and made to swim by means of a thin piece of cork on water, after being excited to an electrical state by friction. The tourmaline, ruby and brazilian topaz readily exhibit this.

The affinity of iron to all the imponderable substances seems greater than that of any other body, electricity, galvanism, heat produced by percussion, and coloured light, rendering the iron magnetic; and the magnetic property, when once acquired, conveying such a sensibility to the metal, to all the impulses of these bodies, that I found, when a number of small needles were rendered magnetic, and so placed as to traverse freely, being connected together at small distances by any light substance, and so arranged in reference to each other, that none of the needles could shew its tendency to the poles of the earth; they then indicated, by *their motion*, the impressions they received from the sun's rays, the radiation of caloric, and the other subtle bodies alluded to; but this will be easier apprehended by stating the following experiments.

Twelve or fifteen needles (of the size marked No. 10, used for sewing) were rendered magnetic, and stuck into a thin circular slice of cork, of an inch diameter, at the distance of one-sixth of an inch from each other. The heads of the needles were so fixed into the piece of cork, that they stood perpendicularly; and all the points being south poles, stood uppermost. The cork was then placed on the centre of a surface of water, 1½ feet in diameter. The needles, in this situation, being prevented from evincing any polar attraction by their perpendicular position, were attracted by a moderate degree of light, heat, or electricity, but were repelled by the more powerful impulses im-

parted by the concentration of any of these bodies. When the rays of the sun were collected into a focus by a lens, and made to impinge on the needles, they moved rapidly on the water from the solar beam. The same effect was produced by a piece of metal heated, and held over the points of the needles. Electricity also seemed to attract or repel them, in proportion to its force.

I also found, that, if the small seeds of plants are dried, and laid upon any good electric, which has been smartly rubbed, and the poles of a strong horse-shoe magnet is moved slowly over the seeds, they will spring from the electric to the magnet more readily than to any other body not magnetic.

Observing, therefore, a considerable similarity between the effects of all these imponderable bodies on plants (the petals of which contain iron), and on iron, I formed a thin piece of silver-plated copper into the shape of the calyx of a flower, and fitted a thin circle of cork to the edges of the copper cup. Into this circle I fixed twenty needles, highly magnetic, at equal distances from each other, in the form of the extended radii of the circle (as represented by the first sketch), with all their south poles pointing outwards, and their north poles directed to the centre of the circle, (destroying by this arrangement their power of indicating their polarity, in respect to the earth). I suspended this by a very delicate filament of silk, from the centre of a glass cover, excluding any current of air, by fixing the cover to a smooth board by wax. I exposed this star of needles to the influence of the solar rays, and it continued first to revolve, and then to vacillate, for the most part of the day; exhibiting, however, when it ceased to revolve, a movement corresponding to the position of the earth in reference to the sun, as the sun was always found opposite to the centre of the arc of vibration. After repeating the experiment for four or five days, the vibrations diminished in the extension of the arc they described; and the movement corresponding to the rising and setting of the sun was more regular and certain. The first combination of this sort which I made was very light. The next I formed intentionally of an ounce weight, to mark the extent of the influence of the solar rays. It was formed in the same manner as the first, with the addition of a circle of zinc round the copper

cup, which I conceived might possibly increase its sensibility, by creating a slight degree of electricity or galvanism. This combination of metals also moved regularly to the apparent motion of the sun, and continued to vacillate as long as the rays of the sun impinged upon the metals; the vibrations diminishing and encreasing with the sun's altitude, being greatest when the sun was near the meridian, and decreasing as the number of the degrees decreased that the sun was above the horizon.

The next form of the instrument I tried, was twenty-five needles fully impregnated with the magnetic fluid, fixed into a circular ring of cork, of about three inches diameter. They were placed at equal distances round the circumference of the circle, with their north and south poles placed outwards alternately. This circle was affixed to a light slip of wood, five inches long, and one-fourth inch broad, by a piece of copper-wire, of a semicircular form, the extremities of which passed through the opposite sides of the cork circle; and the slip of wood was attached to the centre of the wire. Into the centre of the bar of wood was fixed an agate cap; and the whole traversed like a compass needle upon a fine steel point, the bar of wood being equipoised by a small weight at the other end of it, equivalent to the weight of the needles (as represented by fig 2. Pl. I.) This instrument was placed under a glass cover; of a conical shape, and secured from any passage to the air.

When first exposed to the sun's rays, the instrument continued to revolve upon the pivot for several hours, and then settled with one side of the circle pointing toward the sun, in such a position that one-half of the external part of the circle was illuminated by the solar beams, and one-half of the internal part of the ring. In this situation it continued to stand still, in opposition to the diurnal motion of the earth, till the sun sunk beneath the horizon; the points of the needles on the edge of the circle pointing always to the sun, so that the solar rays fell in a direction nearly parallel to the plane described by the star of needles.

This instrument (like all other magnetical instruments that I have made experiments upon) accommodated itself to the peculiarities of its construction. For the magnetic needle, when placed in any situation that may be termed new to it, in respect

to the influence that may affect it, always indicates a greater degree of disturbance during the first experiments that are made upon it, than it does after being subjected to a repetition of them. In a few days, therefore, this instrument ceased to revolve for such a length of time; and after being exposed to the solar rays for five or six days, only revolved for a few minutes, when first it met their influence, but continued to remain stationary, while the pivot moved with the earth, as long as the sun remained unclouded. Towards the sun's meridian altitude, however, when the thermometer was high (about 70°), as if surcharged by the solar rays, it sometimes vacillated a little, or turned quite round, but rested in its usual position ultimately. I found this instrument extremely sensitive, quickly indicating by its motion an increase of heat, light, electricity, galvanism, or a change of colour in the light that shone upon it. It moved readily to any electric, when very slightly rubbed and held near one side of the circle of needles; and to all the prismatic colours, and particularly to the solar beam, when concentrated by a lens, and passed through coloured glass or silk The violet and red ray had the greatest effect upon it.

When a piece of scarlet dark-blue or purple coloured velvet, of a circular shape, is placed over the face of the instrument, so as to cover the needles, the sensibility of the instrument is greatly increased.

When first placed with a disk of purple-velvet across the needles, in the sun's rays, it continued to revolve nearly the whole of the day, moving always in the direction from east to west by south, in the course of the sun's apparent motion. It was attracted by a piece of coal or wood, ignited to red heat

It moved also 40° or 50° to the light of a single candle, held close to one side of the circle. All these experiments were made when the instrument was inside the glass-bell, and the bodies affecting it outside.

The same phenomena were exhibited when the needles were all placed inside of a circle, all their points nearly meeting in the centre, and no part of the needle appearing outside the circumference of the ring When suspended, it turned always one side of the circle to the sun *

* These experiments were made in May and June 1827.

One circle of needles, affixed to a small bar of wood, appears to be the best for making experiments with; but the most preferable form of the instrument for shewing the influence of the sun simply, is to affix two circles of needles to the bar of wood, one at each end, in a perpendicular position *. As the circles always turn their edges to the sun, the bar of wood in this form will be directed to the sun, or to the angle of incidence described by its rays.

In constructing the solar compass, the wood should be of the lightest kind, as willow or British fir. An agate or ruby cap, and a fine steel point, are requisite to facilitate the traversing of the instrument, and fine long shaped needles should be used.

Magnetism is easily communicated to the needles, by two magnetic bars, in the usual way. A paper-full of needles, containing twenty or fifty needles, may be used, as the magnetism can readily be conveyed to the needles at once through the paper: this can be performed by one holding down the paper with the needles, by placing a knife or thin slip of wood upon the centre of the paper, and drawing the bars along it about twenty or thirty times. If they are rendered sufficiently strong, they will spring asunder as soon as the paper is opened, similar poles being in contact. It is necessary that the needles should be fully impregnated with the magnetic fluid.

A piece of clear amber, formed into a convex lens, if fixed into a circle of cork, and suspended, by any fine hair or filament, under a glass cover, will also be so arrested by the incidence of the solar rays, that it will continue to present its surface to the sun, if unclouded, as long as he is visible above the horizon And if, in addition to the lens, there is added a few small bars of amber, attached horizontally to the edges of the circle, it rather increases its aptitude to exhibit the solar influence. The amber I exposed to the beams of the sun, in this form, never ceased to vacillate a little the whole of the day, the sun's position, however, being opposite always to the centre of the arc of vibration.

The power of the solar compass does not seem diminished,

* Represented by Fig. 3. Pl. I

but rather increased, by augmenting the number of the needles. I have tried it with about three hundred needles, and obtained the same results.

It appears to be, to a certain degree, affected by the light of the moon, when full, and also seemed at times, when first formed, to be strangely influenced by the different states of the atmosphere during the night, when the moon was not in our hemisphere. Once or twice, when placed in the open air, in a clear atmosphere, it continued for a considerable time to revolve upon its pivot, stopping occasionally, and then commencing its circular movement. What occasioned this motion I could not discover, except it was some change in the electrical state of the atmosphere.

This instrument, besides exhibiting clearly the power of solar influence on magnetic needles, perhaps might be rendered a good photometer. It might be useful in climates where the sun is seldom shrouded by clouds as a moving dial. Its dip, which is visible when formed of one star of needles, may be useful at sea; and I conceive it is possible, that it may be ultimately made so sensitive as to be attracted or repelled by the sun's influence through its partial obscuration by mist or clouds, and then its utility at sea would be of great service. The instrument is at present affected by the solar rays through thin clouds; and if a piece of cork, of six inches diameter, is cut into a circular shape, and its two flat surfaces made a little convex; and if about two hundred magnetic needles are fixed into one of the surfaces of this lens-shaped piece of cork, radiating from the centre like the petals of a double anemony or daisy, and all the south poles of the needles, placed so as to point to the circumference of the circle; and if this star of needles is suspended under a glass cover, they are affected so far, by the light afforded by a window, that, whether the sun shines clearly or not, the side of the cork on which the needles are placed will not rest opposite to the light, but the circle will either turn its edge or the side without the needles towards the window, before it remains stationary.

And here I feel inclined to offer a few remarks on the theory of magnetism, which are naturally suggested by the facts which have been stated.

The great similarity that subsists amongst the general charac-

teristics of the laws that govern many of the phenomena exhibited by light, heat, electricity, galvanism, and magnetism, has led many to conclude that they were only a modification of the same subtle fluid, or that the principal material that occasioned the effects these agents produced, was variously mixed in close affinity with other substances too etherial for us to detect. What I have already detailed seems to favour this conclusion.

The most prevalent idea that has long existed respecting the theory of magnetism, is, that the magnetic influence proceeded from the north pole of the earth, and was originated either from the abundance of magnetic and iron ore, that was likely to be found there, or from some fluid which unceasingly emanated from the north, similar to the aurora borealis. And, latterly, the polarity of the needle has been referred to the magnetism of the whole earth, or to a law of nature, similar in its simplicity to gravitation. The north pole* has, however, been considered the most important of the two poles of the magnetic needle, and the north the great seat of magnetic attraction, even by the latest writers. I cannot perceive, however, that the grounds upon which this hypothesis is framed are conclusive, or that they do not admit of as clear an explanation being given of the chief phenomena of magnetism, by taking an impartial view, in some respects the reverse of that which is generally maintained, at least in so far as regards the notion that the north pole is the chief magazine of magnetic attraction.

M. Prevost and others, who conceive that the magnetic fluid is composed of two distinct substances, one of which tends to the north, and the other to the south, suggest that the sun is most probably the source of one of these substances; and I would humbly propose, but with the utmost deference to those who are more able to judge, whether we may not reasonably entertain the idea, that the sun is the chief source of magnetism? If we take into consideration both the facts already alluded to, and also take a combined glance at the facts already generally known, and explain them upon this principle; it appears much more clear and plausible than we would at first be inclined to apprehend.

* I use the term North Pole in the same sense as the French writers, for the pole which points to the north.

If we simply consider that the south pole of any magnet possesses as great a power of attraction and repulsion as its north pole, that the compass needle diminishes in its variation as it approaches the equinoctial line, and increases both in its annual and daily variation as it advances towards the north pole; and, after passing a certain degree of latitude, loses its power of exhibiting its polarity altogether; reasoning analogically, we should be led to a conclusion the opposite of that usually held.

The fact, that the sun in the Arctic Regions produces a more visible and extensive variation in the magnetic needle than in the latitudes near the equator, seems to indicate, that the needle within the Arctic Circle is more free to move to any incidental impulse, than when near the Torrid Zone; and we would naturally be inclined to conclude from this circumstance (*nihil contradicente*) that it possessed near the Arctic Regions, both less polar attraction and less local, than when near the Equator.

The observations made by Captain Parry and his officers demonstrate, that the needle, in its diurnal variations, was influenced by the sun, and that the south pole of the magnet was attracted *to* the sun; the maximum westerly variation of the north pole of the needle having been observed to occur at Port Bowen, between 10h A. M. and 1h P. M., and the minimum between 8h P. M. and 2h A. M.; and the diurnal variation sometimes amounting to 6° and 7°.

It was likewise discovered, that an increase of magnetic intensity was exhibited from the morning to the afternoon, and a decrease from the afternoon to the morning. Captain Parry farther observed, "that it appeared that the sun, and, as we had reason to believe, the relative position of the sun and moon, with reference to the magnetic sphere, had a considerable influence, both on the intensity and diurnal variation," (of the needle)*.

It therefore appears to me to be perhaps as consonant to general observation, if not more so, to conclude, that when the

* One of Captain Parry's officers, who was frequently employed in watching the movements of the needle at Port Bowen, mentioned to me, that he sometimes observed a considerable deflexion of the needle just at sun-rise, when the atmosphere [illegible] clear

compass needle ceases to act, in the most northern latitudes, it is because the magnetic influence there is feeble and unequally supplied, and not because the needle is then placed over the very seat of magnetism. And that the cause of the needle's pointing due north and south when near the Equator without any diurnal variation is, because it is there always fully acted upon by that combination of light, heat and electricity, or the component parts of those bodies, that may produce the magnetic fluid; and which are so abundantly and constantly generated around the Torrid Zone; and which ever exist there more or less, in such force as to render the direct diurnal influence of the sun comparatively inferior upon the compass needle, and therefore incapable of producing much daily variation.

It is evident that there must be an everlasting emanation of caloric, light and electricity from the Equator, verging to the north and south poles of the earth. And it is obvious, that whether they are distinct bodies, or only states of bodies, that the sun is the great agent that produces these phenomena, or regulates their movements. And, as this must create a continual *flood* of light, heat and electricity, advancing in the direction of the meridional lines to the north and south, and pervading the whole of the atmosphere and surface of the globe; and as the magnet is attracted and repelled by these bodies, according to their various modifications, it is not perhaps unreasonable to conclude that it is highly probable, that the unceasing motion of those bodies from the central line of the earth to the poles, may be the principal cause of most of the phenomena that are connected with the polarity of the magnetic needle.

The property which Mr Barlow's plate possesses, of causing the needle to continue its action beyond the degree of latitude where it would otherwise cease to act, appears to me to be a farther confirmation of this view of magnetism, as iron seems to retain always more or less of the magnetic fluid, or something very analogous to it, and the rectifying plate will therefore for a time supply the deficiency at the poles of the earth.

If this view of this branch of magnetism is correct, it would not be difficult to conceive why a magnetic needle should assume a position parallel to the magnetic meridian, or nearly parallel to the true meridian of any part of the earth, as it would, being

attracted by the magnetic fluid, necessarily place itself parallel to the direction of the current of that fluid.

But this will be still more easily comprehended if we attend to the manner in which magnetism is communicated to a bar of steel; and we would observe that the general notion, that the poles of a magnet, when used in communicating magnetism to a bar of steel, produce their opposites, is not literally true, as either the North or the South Pole of the magnet produces always both a North and South Pole. And it depends entirely on what part of the bar, to be rendered magnetic, we first place the pole of the magnet, to determine where any of the poles shall be. If, for example, we place the south poles of two magnets upon the extremities of a bar of steel, and draw them towards the centre of the bar, we render, by a repetition of this operation, both the extremities south poles, or similar to the poles used; and the two north poles will be found at the centre of the bar of steel; and a needle thus treated will stand east and west, or north and south. And as any single pole of a magnet will communicate both a north and south pole to any bar of iron, the part of the bar it touches first being always a pole similar to itself; and the part it is in contact with last, being necessarily of the opposite description; this seems unfavourable to the idea that there are two magnetic fluids.

The magnetic fluid simply seems to follow the first direction that is given to it along any piece of steel; and which can only be changed by drawing a magnet along it in an opposite direction, as almost all our compass needles are rendered magnetic by drawing the north and south poles of two magnets from the centre of the needle to its extremities. Each of our compass needles possess actually four poles; they have a north and south pole at their centre, and the same at their extremities.

It is evident, therefore, that the magnetic fluid (or whatever it may be), will run along a bar of steel, in any way it is directed. It will commence at both the extreme points of the bar, and give out at the centre; or it will commence at the centre, and run off by the extremities; and the ends of the same bar may be made both north poles; or they may be rendered both south; or alternately north and south.

If this theory of magnetism be correct upon the whole, and

if we find that the south pole always receives the magnetic fluid, and the north gives it out, it follows that it must necessarily point north and south, according to the direction of the current that moves it.

Upon this principle also, we would readily conceive why the needle dips when rendered magnetic, as it will be disposed to dip to the inclination, which the stream of the subtle bodies, already alluded to, must assume in passing continually from the sun and central parallel line of the earth, to the north and south poles.

The sun, indeed, in a clear atmosphere, has a visible effect on the dip of the needle. And if we take a thin bar of steel, about the thickness of the main-spring of a watch, and two feet in length, and render it magnetic, and balance it on a fine pivot, we can observe a slight variation occasionally in the dip of the needle, by a graduated scale, placed opposite one of its extremities, corresponding to the clearness of the atmosphere and time of the day.

Upon the same principle also, the annual variation of the magnetic needle may be partly accounted for, by the radiating heat produced by the sun, and the other fluids already mentioned, being conducted in greater proportions for a course of years towards the western part of our hemisphere, from a combination of causes no doubt similar to those which sometimes produce a series of warm seasons to the west, and sometimes to the east of the world; and perhaps this may be affected by the comparative progress of cultivation in the different nations of the earth. And this seems to coincide with the accounts of our late navigators, who have found the ice more melted toward the west than toward the east of the North Pole.

I should conceive it to be but a very imperfect method of determining the magnetic intensity at any place, to subject the needle to vibration or torsion, as the state of the atmosphere, the influence of the sun at different periods of the year, and at different times of the day, local attraction, the attraction of gravitation, and the law of the vibration of the pendulum, must all have their share in the calculation; and all these may be modified by circumstances not readily perceived.

Brighton Crescent, Portobello,
1st October 1827.

On the *Semamith of Solomon*, Prov. xxx. 28. By the Rev. David Scot, M. D. M. W. S. F. H. S. E. Communicated by the Author *.

We are told in the 25th verse of the 30th chapter of the Proverbs of Solomon, that there are four things little on the earth, but endowed with great wisdom; and in the 28th verse of the same chapter, we learn that the last of these four things is called *semamith*, which lays hold with its hands, and is in kings' palaces.

As no other instance of this word *semamith* occurs in the Hebrew Bible, several absurd interpretations of it have been given by the Jewish doctors. All these we shall not spend time in considering, but only notice two of the least objectionable, in addition to the commonly received interpretation.

The first of these makes the *semamith* a swallow, but for no other reason, which we can conceive, than a similarity of sound in *senunith*, the Chaldee name for that bird. There may be cases, in which the meaning of a word may be learned from another, resembling it in sound; but in others, such a resemblance will lead into gross mistakes.

The swallow, to be sure, builds its nest in the windows, and sometimes the chimneys of our houses, and they may do so in Palestine; but such a fact would not warrant the declaration, that they lay hold with their hands, and are in kings' palaces, as it would be grossly absurd to talk in that manner of any winged animal.

The other interpretation referred to makes the *semamith* an ape, which is a very shrewd animal, occasionally a favourite of princes, and also furnished with two fore-legs, with which it can seize objects, which, in a loose way of speaking, may be called hands.

An ape, perhaps, may not be thought too large for being called a little thing on the earth; and most will agree that it may excite attention, if not wonder, by its tricks; but it does not go into palaces, unless by constraint. These must be deserted, before it choose them for its ordinary residence.

* Read before the Wernerian Natural History Society 7th April 1827.

To avoid these incongruities, recourse has been had to the spider, and certainly this insect can quote a host of names in its favour. With a surprising uniformity, its cause has been supported by Levi, Elias, and Kimchi among the Jews; by Santes, Arias, Mercer, Munster, Castalio, Junius and Tremellus among Christians: in short by the English, Italian, and Geneva translators.

That the spider is found in kings' palaces as well as in the houses of meaner men, is unquestioned. The species of spiders are numerous, and one of these has the peculiar attribute of the house spider.

This species of spider, however, is oftener in a cottage than a palace, because there is less tolerance for such an insect in those buildings where there is more scrubbing and sweeping. In neglected forsaken apartments, containing useless or forgotten lumber, they are most ready to take up their abode.

But granting that palaces were not kept so neat and clean in ancient as in modern times, or that in warm climates it is more difficult to free buildings even of the better sort from insects, yet, we apprehend, that the spider, which is larger of size in warmer climates, and multiplies faster, will neither be a welcome nor a frequent guest in kings' palaces. It will oftener obtain an entrance into mean houses. It is encouraged by the carelessness which prevails among the inmates, or the quietness which reigns through the apartments. In this manner, at least, Plautus, in the *Aulalaria*, talks of the dwelling of poor Euclio:

...........“ nihil est questi furibus.
Ita inaniis sunt oppletæ et araniis.”

Nay, when spiders abounded about one's house or furniture, the circumstance was deemed a sign of poverty; thus, Afranius, quoted by Festus,

“ Tamque arcula tua plena est aranearum;”

In these terms Catullus excuses the meanness of an entertainment to a friend,

“ Tui Catulli plenus est sacculus aranearum;”

And old Hesiod exhorts, in the 474th line of his works and days,

Εκ δ' ἀγχειων ελασεις αραχνια.

“ You must drive away spiders from your vessels,” *i. e.* banish poverty from your houses.

These quotations seem to shew, that, according to the experience of mankind, spiders are rather found in the cottages of the poor than in the palaces of kings; but quite the reverse is the testimony of Solomon, who had seen so much of life, and thought so much of nature, if his ordinary interpreters have done him justice.

The *semamith,* which is commonly interpreted the spider, is said to take hold with its hands, while in kings' palaces. The house, as well as many other spiders, has eight legs, and, from the structure of these, it can move along the under surfaces of the planks and rafters of a house, like the common fly, and several animals of the lizard tribe.

Now, the legs with which this operation is carried on, have sometimes been called fingers. They are so called in the Frogs, a comedy of Aristophanes, and in the 6th book of Ovid's Metamorphoses. These are the words of the latter:

"In latere exiles digiti pro cruribus hærent."

Even when these are called fingers, the language is highly figurative; but the figure would border on absurdity, if it made the row of feet on each side a hand, to which it has not the least resemblance. Indeed, we do not recollect a passage in any author, in which hands are assigned to the spider, though we recollect one in which there is a direct assertion to the contrary. The spider itself speaks,

"Nulla mihi manus est, pedibus tamen omnia fiunt."

Among the feet with which, according to this assertion, it performs every thing, the two feelers may be included. These are not organs by which it moves, but sometimes assistants when it seizes its prey with its teeth. We do not know how poets or orators would describe this action; but if they should say that it lays hold with its hands, the language would neither be very obvious nor very intelligible.

If, however, laying hold with the hands is to be viewed as a figurative description of the spider's spinning its thread, and weaving its web, these actions are seen with far more advantage in the country than in a palace. In a misty morning during summer, the webs of the field spider are hung from twig to twig, among the surrounding thorn hedges and whin bushes, as far as the eye can reach; but though admiration may be thus

awakened at the thought of the industry as well as the numbers of this insect, yet the chilling recollection is apt to steal on, that all these webs are instruments of destruction, snares for catching as prey, those little unfortunate beings who happen to be entangled.

These operations of the field-spider have been beautifully illustrated by the Abbé Pluche, in a work once very popular, but now little read, entitled, *Spectacle de la Nature*, or Nature Displayed.

But whatever occasion these operations of the field spider may give to ornamented description, they have nothing to do with the proceedings of the *semamith*, as mentioned by the wise king of Israel; and, therefore, that his account may be consistent, we are forced to look about for some other animal.

To the lovers of truth, we will be justified in so doing, after they understand that the *semamith* is not the ordinary name of the spider in the Hebrew language. This is *ocubish*, which has become *ocubim* in Chaldee, and *unkubus* in Arabic, both of which signify a spider.

In the Hebrew Bible, there are two passages in which the spider, under the name of *ocubish*, is mentioned. One of these is in Job viii. 14, "The hypocrite's hope shall be cut off, and his trust shall be a spider's house or web." The other is in Isaiah lix. and 5, "they hatch cockatrice eggs, and weave the spider's web." In these passages, every one sees that the proper work of the spider is noticed.

We allow that this insect, or any other thing, may have two names, provided that the one recall some idea which is not suggested by the other; and we would not object to *semamith*, as the name of the spider, more than to *ocubish*, if the accounts accompanying the use of the former, corresponded as well with the habits of the insect, as they do when the latter is used.

From the want of this correspondence, several ancient as well as modern interpreters have been persuaded, that the animal denoted by *semamith* belongs to the lizard, and not the insect tribe. The Septuagint translators, who are more ancient than any other, and whose authority is entitled to high regard, have rendered *semamith* by the term *calabotes*, which Hesychius the

lexicographer declares to be a certain fish or a lizard, ιχθυς ποιος και σαυρος.

As lizards are not unlike fishes in shape, and some of them live in water as well as on land, that expositor was to be excused, who contended that Solomon meant a fish by *semamith*, though it required no great reach of thought to discover, that fishes are not the residents of a king's palace, however they may inhabit his ponds.

The *calabotes* of the Septuagint is rendered *stellio* by the Vulgate interpreter; and many lizards may be called *stelliones*, because of the variegations in the colour of the skin, peculiarly brilliant in warm countries. Hence, Ovid says of the *stellio*,

> .... "aptumque colori
> Nomen habet, variis stellatus corpora guttis."

This rendering of the *semamith* by the Septuagint and Vulgate is supported by the Syriac, Chaldee and Samaritan translators. The term which each employs signifies *stellio*, or a spotted lizard.

Bochart, in his Hierozoicon, says, that there are two species of *stellio*, the one poisonous and the other harmless; but doubts which was meant by the *semamith*. If it be the *stellio* reputed poisonous, *sem* with a *samech*, which is convertible with *sin*, according to some, will signify poison, and of course the *semamith* will be the poisonous lizard. Others, however, pronounce *shemamith*, and bring it from a verb, which signifies to stun or stupify; and they think this lizard is so called, because it stuns or stupifies the scorpion, to which it is said to be a determined and terrible enemy. So Galen, De Theriaca ad Pisonem, asserts, that "the *stellio*, as soon as seen by scorpions, stuns, and so destroys them;" and Ælian and Isidore, &c. agree with Galen in ascribing to the *stellio* this power over the scorpion.

But what is still more to our purpose, in proving the *semamith* to be a *stellio*, is this sentence of the Talmud, treatise on the Sabbath, chap. 8. "The terror of the *semamith* is upon the scorpion," a sentence which cannot be predicated of any spider, however formidable. Every spider has no other way of catching its prey, but by entangling it in its web; and the scorpion must have a far stronger and fiercer creature to deal with, when it is almost deprived of sense and life, at its very sight.

Now, if the *semamith* be a lizard reputed poisonous, Bochart informs us, that the Arabs have a lizard to which they give the name of *samabras*, signifying a spotted lizard, or the lizard which has spots like a leper, and to which the *semamith*, if accounted poisonous, may answer.

If, however, the *semamith* be the *stellio* accounted harmless, Bochart thinks it may be the *wezgu*, which is less in size than the *samabras*, and so far suits the account which Solomon gives of the *semamith*, that it is a thing little upon the earth.

But whether the *semamith* be the *samabras* or *wezgu*, as Bochart has endeavoured to establish, lizards are most abundant in warm and dry countries; and as Arabia does not yield to any country in these respects, it may be called the land of lizards. They are present wherever a tent is pitched or a house is reared. The Arabs, who are continually infested with their presence, have a name for every species; and we believe, that, in no language spoken on the face of the globe, is the nomenclature of this tribe of animals more perfect than in Arabia.

With or without reason, this creature is detested by the Arabs, as it was by the Greeks and Romans, Jahius, the son of Chomer, asserting, that the man who killed 100 *stelliones*, would be dearer to him than he who redeemed 100 slaves; and Antonius Liberales, that they were abhorred by gods and men, and that he that slew one of them, did a most acceptable service to Ceres.

All lizards, into whatever divisions, *stelliones*, *geckos*, *iguanas*, &c. they may be marshalled, have four feet. The hind, but especially the fore feet, very much resemble the arms and hands of a man. Whoever has seen any of the lizard tribe, will be instantly struck with this resemblance; and on this account, all the individuals of the tribe, which are very numerous, have been properly and strictly called *Lacertæ*, that is, creatures with arms or hands.

Supposing the *semamith* of Solomon a lizard, it is most consistently said to take hold with its arms or hands, in moving from one place to another, that it may catch flies, which are its ordinary food, elude the pursuit of its enemies, when it moves along places which they cannot reach, or secure its safety, if its back be undermost. In these respects it was natural for him

to admire its dexterity, and declare that it discovered great wisdom, though it was little on the earth.

Indeed, every reflecting person would be filled with amazement, when he beheld this little animal creeping up the walls, or along the ceiling of a house, grasping, as it would seem, the inequalities of the timber, and roughnesses of the stones, that its fall might be prevented, and its journey, perilous, at least, if not impossible to other creatures, accomplished.

The animal, which performs such feats of daring and skill, loves to frequent houses of every name, new houses as well as old, palaces as well as cottages. Aristotle says, that it dwells in stables; Antonius Liberalis, that it is found near common shores; Pliny, that it resides in slaughter-houses, windows, caverns and tombs; Arnobius, that it nestles in the cavities of statues; and Mathiolus, that it lodges in the holes of walls near the ground. With great propriety, then, it has been called the house-lizard, by Porphyry, as quoted by Eusebius, by Suidas, by the Etymologist, and Phavorinus, among the Greeks; and by Alhasim, an Arabian physician of Bagdat.

Aristophanes, Dioscorides, and Avicenna declare, that this lizard fastens itself by its hands to the roofs of houses, but sometimes losing its hold, drops down among the dishes on a table, and poisons the liquor of the cups, if it happens to touch it. Those may believe this account who can, but our faith is not strong enough to credit what Bustamentinus of Complutum asserts, that, when, by some accident, these animals have been mingled with the food, they have poisoned whole nations. Many are the remedies prescribed against these poisonous results by Ætius, Paulus Ægineta, and Avicenna, but whether they be dictated by knowledge or error, is another matter.

That lizards of all kinds are very numerous in Syria, these words of Bruce demonstrate: "I am positive that I can say without exaggeration, that the number, I saw one day in the great court of the Temple of the Sun at Balbec, amounted to many thousands. The ground, the walls and the stones were covered with them; and the various colours of which they consisted, made a very extraordinary appearance, glittering in the sun, in which they lay sleeping and basking."

Where lizards are so numerous, there must be many species; and, after all that has been done to clear up differences, considerable confusion must still remain, two or more species being described as one, while the same name is given to two or more species.

While we acknowledge our obligations to Bochart for the chief materials of this essay, we regret that we have not had the power of perusing Scheuchzer, who has treated at great length the natural history of the Bible; and we have not read or heard of any, who has attempted to point out the kind of lizard which corresponds with the *semamith* of Solomon.

Cuvier's *Stellio* of the Levant may be mentioned, the synonyms of which are the *Stellio lacerta* of Linnaeus, the *Koscordylos* of the modern Greeks; though not the *Hardun* of the Arabians, if we mistake not, which rather answers to what is called the land crocodile. It is this *Stellio* of the Levant, which is often killed by the Mahometans, for mocking them, as they suppose, by lowering its head, when they say their prayers.

Or Solomon's *semamith* may be the *Gecko des murons* of Cuvier, the synonyms of which are the *Gecko* of Hasselquist, the *Gecko lobatus* of Geoffroy, the *Lacerta Hasselquista* of Schneider. It is very frequent in the houses of all those countries, bordering on the Mediterranean to the east and south. At Cairo, it is called *Abou burs*, or father of the leper, because it is supposed to communicate the leprosy to those who eat the food which it has touched with its feet. When it creeps over a person's hand, the skin inflames; more, perhaps, says Cuvier, from the delicate sharpness of its nails, than the deleterious matter which it communicates.

We know not whether the *Lacerta ocellata*, as it has been called by some, be different from the lizards just mentioned. It is about a span long: the feet are short, and five-toed in general: The colour is greenish-grey, with brown spots or disks. It is a native of Egypt, we presume also of Palestine, and frequents houses.

Upon the whole, both authority and probability favour the idea, that the *semamith* of Solomon is a house lizard, and not a house spider; though at present we are unable to say which species of house lizard has a preferable claim to every other.

On Vegetable Substances growing on the bodies of living Animals.

IN a letter from Dr Samuel S. Mitchill of New York to Professor A. P. De Candolle of Geneva, in Silliman's Journal, March 1827, there are some interesting observations stated with regard to vegetable substances growing on the bodies of living animals.

His attention was called to these curious appearances in the year 1808, when W. A. Burrell, Esq. brought him, from his own plantation in Virginia, the larva of an insect, upon which a vegetable had fixed itself, and grown to a considerable size. From its appearance, he was induced to consider it as belonging to the species of *Melolontha*, whose grub is destructive at times to the roots of grass, in meadows and pastures. The vegetable was single, and, although somewhat injured, yet the lower part of the stem and the point of attachment, were very distinct.

Some years afterwards, another vegetating insect was presented to him by Dr W. M. Ross, who obtained it in Jamaica, during his residence there. It was a full grown Sphynx, whose whole body had been covered with a vegetable crop, issuing thick from the thorax and abdomen.

Another Sphynx, similarly covered with vegetables, was subsequently shewn him by Dr J. B. Ricard Maddiana, who brought it from Guadaloupe.

This gentleman also gave him several vegetating wasps, procured by himself in the same place. On the 16th June 1823, while on a botanizing excursion at Bay Mahaut in the above island, he saw lying on the ground a wasp's nest, which had fallen from a branch of *Laurus persea*. Some of the animals were flitting about over the cells, and, by the softness of their wings, and the faintness of their colours, were easily known to have been hatched but a short time. Many others were lying dead on the ground. On examining these, he instantly perceived vegetables proceeding from their bodies, and this uniformly from the anterior part of the sternum or thorax. Some of the cells still contained young wasps in the larva state, and which had not reached the last stage of their metamorphosis. He

drew them from their cells, and satisfied himself that there was an incipient vegetation, and moreover that its progress had kept pace with the growth of the chrysalis. It was remarked, that rarely or never was there more than one vegetable on a single wasp.

He then satisfied himself why the vegetable parasite was situated on the fore-part of the body. Botanists have pronounced this production to be a species of *Sphæria*, belonging to the natural order of *Fungi*. Upon the supposition that it is propagated by seeds in the ordinary mode, these seeds would naturally alight upon the most exposed part of the unhatched insect that was accommodated for their reception. This would of course be near the head. Being fixed there, it would increase with the enlargement of the animal, and drawing nourishment from its body, would continue to grow even after it had attained its last and perfect state, until the *Sphæria* had destroyed the life of the wasp.

The mind becomes reconciled to the idea of a vegetable sustaining itself upon a living animal, by considering the history of the Ichneumon, an insect of the Hymenopterous order. It is called *pupivorous*, on account of the voracity with which its larvæ devour the larvæ, chrysalids, and even eggs of other insects, more especially those of the Lepidopterous order. Some of them penetrate the bodies of their prey, and, with their numberless brood, slowly consume and at last kill them; while others, the Ophions, are attached to the skin of the larva by the footstalk of a cocoon, through which their heads pierce the internal parts, while their tails remain in their own inclosures. This operation frequently continues until the large invaded larva completes its cocoon, when it dies consumed and exhausted. After this, the family of ichneumons come forth, first bursting their own cocoons, and then that of their prey. It is also stated as a fact, that one species of Ichneumon sometimes destroys the larvæ of another species of the same genus. These occurrences furnish strong and instructive analogies.

Here we find that the living bodies of caterpillars and their chrysalids, are the habitations and nurseries of other insects, the Creator having arrayed one tribe against another, apparently for the purpose, among others, of putting a limit to their own

excessive multiplication. There seems also to be another check upon their inordinate increase. The fungous tribes of vegetables are in various instances the destroyers of the insect race. Their germs or seeds, conveyed by the winds or otherwise to the surface of these creatures, find them to be situations fit for their adhesion.

If it now may be considered as certain, continues Dr Mitchill, that a vegetable may grow upon the larva or chrysalis of a wasp, and continue to increase until they change into the complete or imago state, and after, why may not the like happen to the larva and chrysalis of the Sphynx and Melolontha? The presumption is strong, that the seeds were scattered on the back and sides of the larvæ, exposed everywhere to their influence, and not incased and protected like the young wasps. Whence it might be inferred they would germinate and enlarge until after the beginning of the fourth metamorphosis, when they would probably overcome their supporter.

Dr Maddiana, however, thinks, that, in some instances, the vegetation commences only after life has ceased. Dr Mitchill continues to adduce instances of vegetable substances issuing from the bodies of insects; and in conclusion draws the following inferences: 1. That this kind of vegetation is not confined to a single species of insect, but obtains in several, viz. the Wasp, Sphynx and Melolontha, there being also reason to suppose that it extends to others: 2. That the bodies of insects nourish more than one species of vegetable, as the Sphæria, Clavaria, and probably others not yet investigated: 3. That a part, at least, of this order of parasitical vegetables, begin their work of annoyance, like the larvæ of the ichneumon, in the body of the living insect, and continue it until the creature is killed by its destructive inroads: 4. That these mixed associations of vegetable with animal matter, are not prone to rapid putrefaction, but remain long enough to be collected by naturalists, and become the objects of scientific inquiry.

The chief or leading fact intended to be established, is the derivation of nourishment by the vegetable from the *living* animal, which the Doctor thinks may be rendered more admissible, when we reflect that the bodies of *dead* animals support vegetation, in the form of manure and otherwise, and that many

Crustacea and Mollusca are invested with a dense vegetable covering.

On the relative Proportions of certain parts of the Eye of the Fœtus, compared with the same parts of the perfectly developed Eye. By Professor Carus.

The remark has already been made by some anatomists and physiologists, that the human eye, as well as all the organs, runs through a series of degrees of development, in which its analogy with the eye of animals is so much the greater, the nearer it is to its first formation. The object of Professor Carus, in his memoir, is to follow out this proposition in some of its details. The following are among the most interesting results of his investigation.

The eye of man, compared with that of animals, presents the most extended retina, in proportion to the size of the eye-ball (consult Sömmering's Plates, *De Oculorum hominis animaliumque sectione horizontali*, Götting. 1818). The vitreous body of the human eye is the largest of all, compared with the bulk of the crystalline humour: the portion of the eye-ball which covers the transparent cornea, and which allows the iris and pupil to appear, is smaller in proportion to the part which the sclerotic covers; and this proportion is modified only in birds, especially the birds of prey, in which the extraordinary breadth of the ciliary processes puts limits to the extension of the retina, which is kept at a distance from the edge of the cornea. In the eye of animals, also, the sclerotic scarcely appears under the palpebræ, while a considerable portion of it is visible in the human eye.

It is equally observed, in the different forms of the latter, that the relation of the extent of the iris and pupil, to the surface of the visible portion of the sclerotic, is not always the same. In children, the iris and pupil have a greater proportional extent, exhibiting an analogy with the eye of animals; and in adults a large iris with its pupil, seems to us rather to be the expression of physical power, while an eye in which the contrary takes place, and in which the sclerotic coat shews itself to a great

extent, expresses rather something spiritual or celestial. The pious painters of the old Italian and German schools had a clear idea of this proportion, and in their representations of eyes of virgins, angels, Christ, and saints, it may be seen that the pupil and iris are smaller in relation to the sclerotic, than they are in well formed ordinary eyes. From this it may be presumed, that the eye of the fœtus will equally present modifications in the proportion of the parts of which it is composed. The results which M. Carus has obtained, in consequence of accurate measurements, are the following:

Age of the Fœtus in lunar Months.	Relation of the diameter of the iris to that of the globe of the eye.	Relation of the diameter of the iris to the length of the axis of the globe.
2	$3 : 6 = 1 : 2$	$3 : 4 = 1 : 1\frac{1}{3}$
3	$9 : 17 = 1 : 1\frac{8}{9}$	$9 : 15 = 1 : 1\frac{2}{3}$
4	$12 : 22 = 1 : 1\frac{10}{12}$	$12 : 17 = 1 : 1\frac{1}{3}$
5	$23 : 38 = 1 : 1\frac{15}{23}$	$23 : 33 = 1 : 1\frac{10}{23}$
6	$26 : 45 = 1 : 1\frac{19}{26}$	$26 : 43 = 1 : 1\frac{17}{26}$
7	$30 : 58 = 1 : 1\frac{14}{15}$	$30 : 55 = 1 : 1\frac{5}{6}$
8	$33 : 65 = 1 : 1\frac{32}{33}$	$33 : 62 = 1 : 1\frac{29}{33}$
9	$37 : 73 = 1 : 1\frac{36}{37}$	$37 : 70 = 1 : 1\frac{33}{37}$
10	$45 : 85 = 1 : 1\frac{40}{45}$	$45 : 77 = 1 : 1\frac{32}{45}$
Woman of 60 years, .	$50 : 110 = 1 : 2\frac{1}{5}$	$50 : 112 = 1 : 1\frac{6}{25}$

It is seen from this, that the proportion of the breadth of the iris to that of the globe of the eye, as well as that of the iris to the axis of the eye-ball, increases with age. The following is another table, which presents some points of comparison with the eye of animals:

Animal.	Relations of the breadth of the iris to that of the globe of the eye.	Relation of the breadth of the iris to the axis of the globe of the eye.
Pike *, .	$1\frac{[illegible]}{33}$	$8.5 : 8.5 = 1 : 1$
Crocodile,	$5.0 : 7.5 = 1 : 1\frac{25}{50}$	$5.0 : 6.5 = 1 : 1\frac{15}{50}$
Golden eagle,	$7.5 : 16.0 = 1 : 2\frac{10}{75}$	$7.5 : 14.6 = 1 : 1\frac{71}{75}$
Chamois, .	$10.5 : 14.0 = 1 : 1\frac{35}{105}$	$10.5 : 12.8 = 1 : 1\frac{23}{105}$

There results from all this, that the eye of the fœtus only assumes by degrees the proportions that obtain in the eye of the adult; and that the smallness of the iris, in proportion to the

* Brochet, Esox lucius, *Linn.*

diameter as well as to the axis of the ball of the eye, is one of the characters by which the fully developed human eye is distinguished, both from the eye of the fœtus, and from that of animals.

On the Irritability of the Stigma, and on the origin and nature of certain parts of the Fructification in Pinus Larix. By Mr David Don, Libr. L. S., Member of the Imperial Academy Naturæ Curiosorum, of the Royal Botanical Society of Ratisbon, and of the Wernerian Society of Edinburgh, &c. (Communicated by the Author).

It is a well known fact, that certain plants themselves, but more generally particular organs, are endowed with a species of irritability analogous to that observable in the animal kingdom. While engaged in examining the female flowers of the common Larch, during the last spring, in order to satisfy myself respecting the real nature of the stigma, I was much surprised by the remarkable degree of irritability observable in that organ, a circumstance which I am not aware had ever been before noticed. That the cucullate processes at the base of the ovaria are the true stigmata, is a point so fully established, as to render unnecessary any additional facts in its support. To regard the ovaria as naked ovula, and that impregnation takes place by the pollen being immediately shed on their surface, instead of being conveyed by means of an organ analogous to the stigma of other plants, are opinions by far too paradoxical to admit of belief. These cucullate processes, when fully mature for the reception of the pollen, expand, and their inner surface is then clothed with innumerable minute papillæ. I took a branch bearing unimpregnated female flowers, and having dusted them with the pollen from the ripe male catkins of another branch, I found on examination the cucullate stigmata completely filled with the pollen, and I could readily perceive the sides of the female organ contract gradually, until they finally became completely collapsed. The pollen in *Coniferæ* being composed of minute vesicles filled with a prolific fluid, the collapsing of the sides of the stigmata is evidently for the purpose of pressing out the contents of these vesicles, and forcing the fluid through the narrow duct on to the

ovulum. When impregnation has taken place, the sides of the stigma again expand, and soon after wither. In this state, the stigma is seen filled with the empty cells of pollen. If a branch with female catkins is separated from the tree before impregnation has taken place, it is surprising how long the stigmata will remain expanded and in a perfect state. This circumstance has been also remarked in the female organs of other plants. That the amentum of *Pinus* is nothing more than a modified branch, is well exemplified in the larch, where a comparison between an expanding bud and the female catkin is at once convincing. The bracteæ, which in the larch are persistent, being regarded as altered leaves, the flowers are, therefore, truly axillary, and their situation may be compared to those of *Hippuris.* The fleshy scales, which afterwards compose the cone, are analogous to the nectarium of *Salix*, &c.; and one of their uses, namely, the nourishing the early stage of the ovarium, as the albumen does the embryo, is precisely similar. The ovaria at first are firmly attached to the upper surface of the scales; but on their increasing in size, they by degrees lose the connection, till at length, in the ripe state, they become perfectly free. These scales, in the early state, are fleshy and orbicular, composed of a cellular substance, having neither veins nor nerves traversing them; their upper side is convex, and underneath flat, with an acute, slightly fringed margin; the whole surface is pruinose: in the young state succulent, and gradually increasing in size, they finally constitute the cone, becoming then dry, coriaceous, or woody. In this state, from their arrangement and structure, they admirably serve to protect the seeds from the destructive effects of the severe weather to which in winter they would otherwise become exposed; and we cannot but admire the wise provision of Nature in this instance, which has given to these natives of cold regions the means of protecting their seeds through the winter, until finally matured in the warm weather of the following spring. In judging of the origin and analogies of the stamina in *Coniferæ*, instead of looking for the resemblance in the leaves, we must begin by comparing them with the bracteæ of the female catkin, which we have already shewn to be modified leaves; and it therefore follows, as a deduction, that they are both modifications of the same organ, namely of the leaf.

Essay on the Domestication of Mammiferous Animals, with some introductory considerations on the various states in which we may study their actions. By M. FREDERICK CUVIER. Continued from former Volume, p. 318.

As our means of good treatment are various, and as the effect of each of them differs, according to the different nature of the animals on which they are made to act; the choice of them is far from being a matter of indifference, and they require to be accurately appropriated to the object in view.

To satisfy the natural wants of animals would be a means which eventually might bring about their submission, especially if applied to very young animals The habit of constantly receiving their food from our hand would familiarise them, and render them attached to us; but, unless the employment of this means were continued for a very long time, the bonds which it would form would be feeble. The good which, in this manner, an animal would have received from us, would have been procured by itself, had it possessed the power of acting conformably to its natural disposition. It would also, perhaps, return to its original independence, the moment we might wish to employ it in any service; for it would find, in this state, more than an equivalent for all that it received from us, namely, the faculty of giving itself up to all its impressions. To attach animals, therefore, it would not probably be enough to satisfy their wants; more is necessary; and it is, in fact, by increasing their wants, or by creating new ones, that we attach them to us, and, so to speak, render the society of man necessary to them.

Hunger is one of the most powerful of the means which are at our disposal for captivating animals; and as the extent of a benefit is always in proportion to the necessity which is experienced of it, the gratitude of the animal is so much the more intense, the more necessary the food which we give it has become to it. It is applicable to all the mammifera, without exception; and if, on the one hand, it may give rise to an affectionate feeling, it produces, on the other, a physical debility, which re-acts upon the will to weaken it also. It is in this manner that the training of horses, which have passed their first years in a state of entire independence, usually commences.

After they have been caught, a small quantity only of food is given to them, and at long intervals; and this suffices to familiarise them to those who take care of them, and inspire a certain degree of affection, which the latter may turn to their advantage, by increasing their authority.

If, to the influence of hunger, there be added that of a selected food, the power which the benefit possesses may be considerably increased; and this power arrives at an astonishing point, when, by an artificial food, the taste of animals is much more gratified than it would be, by a better food, which nature had destined for them. In fact, it is principally by means of real dainties, and especially sugar, that we manage these herbivorous animals, which we see submitting to the extraordinary exercises of which our public circuses sometimes afford us the opportunity of witnessing.

This agreeable food acts immediately upon the will of the animal. To obtain, by its means, the effect desired, hunger and physical weakening are not necessary, and the affection which it entertains for its keeper is altogether owing to the pleasure which the animal experiences but this pleasure depends upon a natural want, and all the pleasures which animals may feel, have not, if I may be permitted the expression, so sensual an origin.

There is one which we have transformed into a want in some of our domestic animals, which seems to be altogether artificial, and not to address itself to any particular sense: it is the pleasure of being caressed. I believe that there is no wild animal that does not ask caresses of the other individuals of its species. Even in our domestic animals, we see the young ones affected with joy on the approach of their mother, the male and the female glad to see each other again; and individuals, which have been accustomed to live together, happy in being united after separation.

But these feelings are never expressed in a striking degree; and it is but in few instances that they are accompanied with reciprocal caresses. This kind of testimony, in which the pleasure received is doubled by that given, belongs, perhaps, exclusively to man. It is from him alone that the animals have acquired the want; it is also for him alone that they experience it; with him only that they satisfy it; and as the feeling of

hunger may acquire strength when the food increases the sensuality, in the same manner the influence of caresses may be extended when they more particularly flatter the senses. It is thus that the gentle sounds of the voice add to the emotions excited by the touch, and that these latter are increased by touching the mammae.

All domestic animals are not, by any means, equally accessible to the influence of caresses, as they are to the influence of food, whenever they are pressed by hunger. The ruminantia appear to be little affected by them; the horse, on the contrary, seems to relish them in a very high degree, as do many of the pachydermata also, and especially the elephant. The cat is not indifferent to them it might even be said that it sometimes seeks them with a sort of fury; but it is without dispute in the dog, that they produce the most marked effects: and what deserves attention, is, that all the species of the genus which I have had an opportunity of observing, are similarly affected by them. There was once a she wolf in the Royal Menagerie, on which the caresses of the hand and voice produced so powerful effect, that she seemed to experience an actual delirium, and joy was not less vividly expressed by her cries than by her motions. A jackal, from Senegal, was affected precisely in the same manner, and a common fox was so strongly agitated, that it became necessary to abstain from all such expressions of kindness toward it, from a dread of the disagreeable consequences that might follow. It is worthy of being remarked, that all the three animals were females.

I do not know whether I may put songs, or harmonious modulations of the voice, among the number of artificial wants by which the will of animals is captivated. It is well known that the camel-leaders make use of it to slacken or accelerate the progress of the animals which they conduct. But is not this a mere sign with which the march of these animals is associated, as the sound of the trumpet is with respect to horses, which are thereby apprised that the lists are clear, and that they are to be let loose? I would be inclined to believe so, not knowing any fact that could afford a contrary idea; for what has been said of the power of music upon elephants, has been viewed with some prejudices; at least, so far as my own observation extends, I am con-

vinced that such is the general impression. It would be curious however, to enquire on what foundation this association rests, and what relations exist between sound and the hearing of mammiferous animals, whose voice is so limited as to variation and harmony.

It is not, however, sufficient that the means of attachment always precede the acts of docility which are required; they must also succeed them. Constraint prudently employed does not remain foreign to these acts; and it might be injurious if continued too long. Caresses or dainties make this effect instantly cease; calmness and confidence are renewed, and quickly weaken, if they do not efface, the traces of fear.

As soon as confidence is obtained and familiarity established, as soon as, by good treatment, habit has rendered the society of men indispensable to the animal, our authority may be enforced, and we may employ constraint, and apply chastisement. But our means of correction are limited; they are confined to blows, accompanied with precautions necessary to prevent the animals from escaping; and they produce but a single effect, which consists in transforming the feeling, whose manifestation it is necessary to repress, into that of fear. From the association which results, the first of these feelings is weakened, and sometimes at length entirely destroyed, even in the bud. But the application of force ought never to be without limits, for its excess produces two contrary effects, it either intimidates, or excites hatred. Fear, in fact, may be carried to the point of disturbing all the other faculties. A naturally timid horse, imprudently corrected, and entirely absorbed by his fright, no longer perceives even the gulf into which he precipitates himself with his rider; and the spaniel, so adapted by its intelligence to the chace, and so obedient to the voice of his master, is converted into an undecided, wild, or trembling animal, when a severity without bounds has presided over its education. With regard to resistance, it always commences on the part of the animal, at the point where our authority passes beyond the limits which time and habit had imposed upon its obedience. These limits vary with respect to each species, and to each individual; and the moment they are passed, the instinct of preservation re-awakens, and at the same time the will manifests itself with all its force and independence.

How often do we see domestic animals, and the dog itself, revolt against bad treatment, and exercise the most cruel vengeance on those who inflict it. The very individuals which we regard as vitious, and which we name restive, are only essentially distinguished from those which are possessed of mildness and docility, by more imperious propensities, which often, it is true, no means can captivate, but which, in many cases also, a more judicious application of those commonly used might serve at least to weaken.

I shall not relate the numerous examples of vengeance inflicted by domestic animals, and particularly by horses, upon those who had maltreated them; the hatred which these animals have cherished towards their cruel masters, and the time during which it has been retained by them in all its original violence. Such examples are numerous and familiar; and although they ought to have shown that brutality is a means little calculated to obtain obedience, they have been ineffectual for this purpose, and animals are still treated by us as if we had nothing to subject in them but their will. I cannot, however, forbear mentioning one example which was exhibited by an elephant, and this less on account of its rareness among us, than from the peculiar characters which accompanied it.

This animal was entrusted, at the age of two or three years, to a young man who took care of it, and who taught it various exercises, which he made it repeat for the amusement of the public. It rendered an entire obedience to its master, and felt a lively affection for him. Not only did it submit, without the smallest hesitation, to all his commands, but it was even unhappy in his absence; it repelled the advances of every other person, and even seemed to eat with a kind of regret, when its food was presented to it by a strange hand.

So long as this young man was under the eyes of his father, the proprietor of the elephant, whether the influence of his family restrained him, or age had not yet developed his bad propensities, he conducted himself with propriety toward the animal entrusted to his care; but when the elephant came into the possession of the royal menagerie, and the young man, who was taken into its service, was left to himself, things became changed.

He gave himself up to dissipation, and neglected his duties; he even went so far, in his moments of drunkenness, as to strike his elephant. The latter, from being habitually cheerful, became melancholy and taciturn, in so much as to be thought unwell. It still however obeyed, but no longer with that briskness which shewed that all its exercises were regarded by it as amusements; signs of impatience were even sometimes manifested, but they were immediately repressed. It was obvious that very different feelings were combating within, but the situation so unfavourable to obedience to which this violent state reduced it, did not the less contribute to excite the discontent of its keeper. It was in vain that the most positive orders were given to this young man never to strike his elephant, and that he was made to see that good treatment alone could restore the original docility of the animal. Mortified at having lost his authority over the elephant, and especially at not going through his exercises with the same success as formerly, his irritation increased, and one day being more unreasonable than usual, he struck his animal with so much brutality, that the latter, goaded to the utmost, uttered such a cry of rage, that its terrified master, who had never before heard it emit such a terrible roar, ran off precipitately; and it was well for him, for henceforth the elephant would not so much as suffer him to come near it; at the mere sight of him it became furious, and all the means which were afterwards employed in order to inspire it with better feelings, were ineffectual. Hatred supplied the place of love; indocility succeeded to obedience; and, as long as this animal lived, these two feelings predominated in it.

Benefits on our part are therefore indispensable to bring animals to obedience. As we are not of their species, they do not naturally experience affection for us, and we can only act at first upon them by restraint; but it would not be so on the part of individuals towards which these animals are attracted by their instinct, which are of the same species, to which a powerful tie tends to unite them, and for which the constraint exercised by their kind is a natural state, a possible condition of their existence.

From the moment when they first come together, these animals are opposed to each other in the same manner as the do-

mestic animals are opposed to man, after the latter has become necessary to them, has seduced them and captivated their affections; that is to say, the one may immediately employ force for subjecting the other. It is the elephant, which, by the manner in which it is rendered domestic, furnishes us with an example of this truth. But, to be properly understood, I must first relate certain facts which I have already developed in my memoir on Sociability.

All the social animals, when left to themselves, form herds more or less numerous, and all the individuals of the same herd know each other, and are mutually attached, according to the relations which circumstances and their individual qualities have established among them; and these herds live in harmony so long as no incident occurs to disturb it. But this sort of attachment exists only with reference to the individuals of the same herd; a strange individual is not at first admitted by them, they almost always receive it as an enemy, and bad treatment often reduces it to the necessity of flying.

On the other hand, every isolated individual has need of the society of its fellows; it seeks them out, approaches them, follows them at first at a distance, and, in order to be admitted, renounces its will to the point at which the feeling of self-preservation determines it to defend itself, or to withdraw.

The domestic elephants obeying the man who leads them, are opposed to an isolated wild elephant, in the same manner as every individual of one herd is opposed to those of another, while the solitary elephant is irresistibly impelled by its instinct to approach other individuals of its species, and to submit to them within certain limits.

Elephants, like all other social animals, might therefore immediately employ force for the purpose of subjecting others; and, in fact, this is what takes place in the manner in which wild elephants are reduced to domesticity.

Domesticated individuals, commonly females, are conducted to the neighbourhood of places in which wild individuals have settled. If there be in their herd one which is forced to keep separate from the rest, and even to live solitary, or because, being a male, there are stronger individuals in the herd, or, from any other cause, is impelled by his natural propensity, he quickly

discovers the domestic individuals, and approaches them. The masters of the latter, who are at hand, run up, and confine the strange elephant with ropes, being protected by those which belong to them, and which, on the smallest resistance from the new comer, strike it with their proboscis or tusks, and compel it to submit to be led away.

The chastisements inflicted by the domestic individuals upon the wild individuals, joined to the good treatment which he receives, soon complete his captivity, or, in other words, soon bring about the period when his will conforms itself to his new situation, when his wants are in accordance with the commands of his master, and when he submits to the various labours allotted to him, and which habit soon renders easy; for it is said that a few months only are required to transform a wild elephant into a domestic one.

So long as animals are, to a certain degree, susceptible of affection and fear,—so long as they can attach themselves to those who treat them well, and dread those who punish them, it is sufficient to develope in them these feelings, in order to weaken those which might be opposed to them, and to give another direction to their will. This is what we have obtained by the application of means, which now form the subject of our inquiries and observations. But it happens, either from the nature of individuals, or from the nature of species, that the energy of certain propensities acquires such power that no other feeling can overcome it, and under the empire of which no other feeling can ever arise. For such animals, neither good treatment nor correction will suffice, neither the one nor the other would operate effectually; they would even be nothing else than new causes of exercise to the will, and, in place of weakening, they would exalt it. It is therefore indispensably necessary, with respect to animals which experience so imperious a desire of independence, to commence with immediately acting upon their will, to deaden their rage, in order to render them capable of fear or gratitude; and, for this purpose, the happy idea was suggested of submitting them to a forced state of watchfulness or to castration.

According to all accounts, it appears, that the first of these means, namely, a forced state of watchfulness, is of all the modifi-

cations which an animal may experience, without its being mutilated, that which is best adapted to weaken its will, and dispose it to obedience, especially when benefits and chastisements are prudently associated with it; for then the affectionate feelings experience less resistance, and take root more quickly and more deeply, and fear, for the same reason, acts with more promptitude and more force.

The means which may be employed for suspending sleep, consist in strokes of a whip, applied more or less smartly, or in a loud noise, such as that of a drum or trumpet, which is varied to avoid the effect of uniformity, but especially in rendering hunger urgent, by withholding food; and among the observations to which these different modes of procedure give rise, there is one which it will not be without interest to dwell upon for a moment, although it does not result exclusively from the particular case which we examine, but presents itself under a variety of other circumstances. It shews us, that animals do not know to refer to their cause the modifications which they experience through the medium of sound, whenever certain particular relations do not exist between them and their causes.

When an indocile stallion or bull is struck, it does not misjudge regarding the cause of its pain, but immediately throws itself upon the person who has directed the blow,—even when it may have been struck by a projectile, like the boar which rushes upon the hunter whose ball has wounded it. I do not examine whether experience has any thing to do with their action; this much is certain, that whatever experience these animals may have of the noise from which they suffer, they are never able to refer the cause, either to the instrument which produces it, or to the person who employs this instrument. They suffer passively, as if they experienced an internal disease; the cause, like the seat of their uneasiness, is in themselves, and yet they very correctly discern the direction of the noise. The moment they are struck by a sound, their head and ears are directed, without the slightest hesitation, toward the point from which it proceeds; there are even animals in which this action is instinctive, and precedes all experience; and with regard to the sensations, I might add, that the bull acts upon seeing a red ray, as he would under the impulse of blows. The cause of

the modifications which he experiences, is in both cases entirely external; which shews us farther, that if the horse and the bull do not refer the sound to the instrument which produces it, it is less on account of the distance which separates them from the instrument, than on account of the peculiar nature of the sensations of hearing.

The above means are applicable to all animals, and to both sexes, although they do not produce the same results in all. The means of castration applies only to the male individuals; and it is absolutely necessary only for certain ruminantia, and chiefly for the bull. Almost all the natural wants, when not satisfied, especially when their object is to repair the strength, such as hunger and sleep, are accompanied with a physical weakening. There is one, on the contrary, which seems to increase in proportion as the obstacles which oppose it increase, until it is satisfied; it is love. As we are unable to exercise any immediate controul over it, we mutilate the animals, which experience its effects too strongly, by removing the organs from which it has its principal source.

In fact, the bull, the ram, &c. do not really submit to man until after their mutilation; for the influenc of the spermatic fluids extends in them, as also in all the other animals, much beyond the seasons at which the desires of love are experienced. At no period of their lives have these animals the docility which domestication requires, whereas the ox and the sheep have always been looked upon as models of patience and submission. Hence it follows, that bulls and rams are useful only for propagation; and that in the ram it is only the female that is domesticated.

This operation is not necessary in horses, although those which have undergone it are generally more tractable. The dog, on being castrated, loses all its vigour and activity; and this effect appears to be common to all the carnivora, for the domestic cat is in this respect precisely in the condition of the dog.

It is therefore by wants, over which we are able to exercise some influence, which it depends upon us to direct, to develop, or to destroy, that we are enabled to tame, and even entirely captivate animals; and, from the small number of them of which

we have hitherto taken advantage, we may be allowed to think, that, in practice, we have not yet exhausted this source of the means of seduction,—and that others might be brought to our aid, should new species to be rendered domestic, or new services to be demanded of those which already are so, enforce the necessity of searching them out, and induce us to make the attempt. Although, however, the number is thus limited, it will easily be conceived, that, in applying them to animals of very different natures, the results obtained must vary in a high degree. In fact, scarcely any comparison can be instituted between the dog and the buffalo in this respect. While the one is a pattern of attachment, submission, gratitude, fidelity, and devotedness,—the other is destitute of every benevolent and affectionate feeling, and of all docility. Between these two extremes, come the elephant, the hog, the horse, the ass, the dromedary, the camel, the lama, the rein-deer, the goat, the ram, and the bull, which could all be characterised by the qualities which have been developed in them by the influences to which we have subjected them; but this subject would lead me too far beyond the limits which I ought to prescribe to myself in a mere memoir.

Hitherto I have only considered the general effects which the various means, described above produce upon domesticated animals. It will not be useless to cast a glance over those which they produce in wild animals; for the comparison that will result, will perhaps assist us in eliciting the first elements of domestication.

The monkeys, that is to say, the quadrumana of the old world, which, to the highest degree of intellect in animals, unite the organization most favourable to the development of all the faculties—which have the propensity to unite together, and form large herds,—appear to possess the conditions most favourable for receiving the influence of our means of taming,—and yet no adult male of this numerous tribe has ever submitted to man, whatever good treatment it may have received. I intend confining myself to the guerons, macaci, and cynocephali; for the orangs, gibbons, and semnopitheci, are animals as yet too little known to us to have ever been subjected to experiment. With regard to the former, their sensations are so vivid, their infer-

ences so prompt, their natural distrust so great, and all their feelings so violent, that it were impossible, by any means whatever, to confine them to any particular order of circumstances, or habituate them to a determinate situation. Nothing could quiet their desires, which change with all the modifications they experience, and, even to a certain degree, with all the motions that are performed around them: hence we have never been able to count upon any good feeling on their part; at the moment when they are giving the most striking tokens of affection, they may be induced to tear one with fury; and there is no treason in this, for all their vicious qualities depend upon their excessive mobility.

It appears, however, that, by violence, and by continually keeping them in torment, they may be induced to perform certain exercises. It is in this manner that the islanders of Sumatra succeed in teaching the *Macacus nemestrinus* to ascend trees on being ordered, and collect the fruits; but it is only individuals that are thus trained, and where force is necessarily employed; domestication is not yet effected.

It is in consequence of the same treatment that we see some of these animals, and particularly the magot (*Macacus inuus*), learn to obey their master, and to perform those adroit and accurate leaps, to execute those bold dances which their organization and their natural dexterity render easy for them, and which often strike us with astonishment. Yet they are so exclusively subjected to force, that, whenever they can escape, they run off, and never appear again, if they happen to be in countries to which they can accommodate themselves, and which are calculated to afford them the means of subsistence.

We should better succeed in taming the American quadrumana with pendent tails, such as the ateles, and sapagons, which, to a high degree of intellect and the social instinct, may join an extreme gentleness and a lively desire of being caressed. With regard to the Lemuridæ, so many difficulties would be encountered in taming them, and so few advantages obtained, on account of their untractable and timid nature, that the uselessness of making the attempt would have been discovered, had it been tried. And the same remark applies to the Insectivora, which

would, moreover, have the disadvantage of a very limited intellect, and of an unfavourable organization of limbs.

The carnivora, such as the lions, panthers, martins, civets, wolves, bears, &c. all of them species which live a solitary life, are very accessible to benefits, and little susceptible of fear. In a state of liberty, they retire from danger; in captivity, violence irritates them, and seems especially to carry confusion into their intellect; anger and fury then possess them. But let their wants be satisfied when they feel them keenly; let them experience goodness only on the part of their masters; let no sound of the voice, no motion, give indication of a menacing character; and these terrible animals will soon be seen approaching their benefactors with confidence, manifesting the satisfaction which they experience on seeing them, and affording the most unequivocal demonstrations of their affection. A hundred times has the apparent mildness of a monkey been followed by treachery; but never have the outward signs of a carnivorous animal proved deceitful. If it is disposed to hurt, every thing in its gestures and look will announce it, and the same will be the case when it is animated by a benevolent feeling.

Lions, panthers, and tigers have often been seen yoked to carriages, and obeying their drivers with much docility. Wolves, trained for hunting, have been seen faithfully to follow the pack to which they belonged, and the exercises which bears are made to perform are well known. But although we have been able to habituate these animals to obedience, although we may have succeeded in training them to certain exercises, we have not gone so far as truly to associate them with us; and yet what services might not man derive from the lion or bear, were he able to employ them as he has succeeded in employing the dog.

The seals, which are all social animals, and possessed of uncommon degree of intellect, are, perhaps, of all the carnivora those which would undergo the greatest modifications from our good treatment, and which would perform, with most facility, what we might require of them.

The glires, that is to say the beavers, marmots, squirrels, hares, &c. seem only to be endowed with the faculty of feeling, so little activity has their intellect. They retire from whatever causes them pain, and, on the other hand, approach whatever is

agreeable to them, whence they can be habituated to certain conditions, and even to certain exercises, but they distinguish these causes but very imperfectly; they appear to exist for them only when they act, and to form but little association in their memory. The animal of this tribe, to which we have done most good, does not distinguish us individually, and shows no more satisfaction at our presence than at the sight of any other person; and this is equally true with regard to those which live in society as with regard to those which lead a solitary life.

If we pass to the tapirs, the peccaris, the daman, the zebras, &c. in a word to the pachidermata and solipeda, we find animals living in herds, which pain may inspire with fear, and good treatment render grateful, which distinguish their masters, and sometimes form very strong attachments to them.

A similar effect takes place, to a certain degree, with the ruminantia, but principally the females, for the males, without any exception I believe, have a brutality which bad treatment increases, and which good treatment does not soften.

We learn, therefore, from the facts which have come under our consideration, what influence the various means which have been devised for bending animals and attaching them to our service exercise upon them; but they disclose nothing to us regarding the dispositions which are necessary in order that domestication may result from this influence; for we have seen that several animals receive this influence like domestic animals, without, however, becoming domestic.

Were our action upon animals limited in individuals, were it necessary for us, at each generation, to recommence the same labour, in order to associate them with us, we should not have had, properly speaking, domestic animals; at least domesticity would not have been what it really is, and its influence, upon our civilization, would not have had the results which the wisest observers must have discovered it to possess. Fortunately this action is connected with one of the most important and most general phenomena of animal nature; and the modifications which we have made those animals undergo, which we have first reduced to domesticity, have not been lost with respect to those which have been produced by them.

It is a fact universally recognized, that the young of animals have a very strong resemblance to the individuals which have given life to them. This fact is as obvious in the human species as in any other; and it is not less true with reference to the moral and intellectual faculties, than to the physical qualities. Now, the distinctive qualities of animals of the same species, those which have most influence over their particular existence, which constitute their individuality, are those which have been developed by exercise, and whose exercise has been called forth by the circumstances amid which these animals have lived. Hence it follows, that the qualities transmissible by animals to their young, those which give rise to a mutual resemblance in them, are of a nature to arise from fortuitous circumstances; and, consequently, that we are enabled to modify animals and their progeny, or their race, within the limits which bound our power to produce the circumstances calculated to act upon them.

What is thus established by reasoning, the observation of domestic animals fully confirms. It is we who have formed them, and there is none of their race that has not its distinct qualities,—qualities which make such or such particular race to be preferred to any other, according to the purposes for which it is intended, and which are constantly transmitted by generation, so long as circumstances opposed to those which have occasioned them do not destroy the effects of these latter.* It is by this means that we are enabled to preserve the races in their purity, or to obtain by their mixture races having new qualities, intermediate between those which have been united. But all these facts are so well known, that I consider it superfluous to dwell particularly upon any of them.

It will not, however, be useless to remark, that the most domestic races, those which are most attached to man, are those which have experienced on his part the action of the greatest number of the means, the use of which we have seen for rendering them attached. Thus the dog species, on which caresses have so much influence, without distinction of sex, is indisputably the most domestic of all; while the ox species, the females of which alone experience our influence, and on which we have had no other means of acting, for the purpose of attaching them to us than feeding, is certainly that which least belongs to us.

And this difference between the dog and the ox would still necessarily be increased by the difference of fecundity of these two species. In fact, the dog, in an equal time, submits to our influence a much greater number of generations than the ox. We are ignorant what dispositions the dog originally had to become attached to man and to serve him, and upon which consequently man might have acted to bring him to the degree of submission to which he has arrived; but there is every reason to believe that they were numerous: and with the promptitude with which the elephant becomes domestic, it is extremely probable that if our influence could be exercised over a certain number of its generations, it would become, like the dog, one of the most submissive and affectionate of our animals, inasmuch as all the means adapted for rendering animals domestic are calculated to modify it. Unfortunately no pains have been taken in attempting to make it breed; and, in the countries where its services have become necessary, the natives have contented themselves with taming individuals. This transmission of individual modifications by generation does not, however, afford a basis to domestication, although it is indispensable to it. It is a general phenomenon which has been observed in the wildest animals, as in those that have been most subjected to our will. Let us inquire, therefore, now that we know the animals which are associated with us, what is the disposition common to some and foreign to others, which might be regarded as essential to domesticity; for without a particular disposition, which would second our efforts and prevent our empire over animals from being merely accidental and transitory, it is impossible to conceive how we should have succeeded.

(*To be concluded in next number.*)

On a new Gyrogonite, or Fossil Capsule of the genus Chara, occurring very abundantly in the fresh-water Limestones of the neighbourhood of Paris. By M. Constant Prévost.

The author commences with a historical account of the Gyrogonites, in which he relates all that has been said regarding these small bodies, which are now generally considered as fossil seeds of the genus Chara. In Forfarshire, the analogous fossil

chara form part of one of the newest deposits, the formation of which, if it does not belong to the present period, is at least more recent than the diluvian deposits on which the Forfar marls rest On the contrary, the gyrogonites observed by M. Constant Prevost, in the upper fresh water limestones of the neighbourhood of Paris, are connected with an older formation, probably anterior to the great revolution which has left the globe in its present state. This difference of position it is of importance to remark, because it serves to connect, by insensible shades, the productions of nature as it exists at present, with those of the period when the soil on which we now live was formed.

The new gyrogonite observed by M. Constant Prevost, is not less abundant in certain localities of the heights of Montmorency, than the *gyrogonites medicaginula* along with which it occurs. It differs essentially from this latter in its form, which is elongated ovoidal; in its size, which is less by a half or even two-thirds, a circumstance which renders it scarcely perceptible without the aid of a glass, lastly, in the number of spiral turns, which, in place of being six, vary from nine to ten. These characters prevent our confounding the new gyrogonite with the two species described by M. Ad. Brongniart, and they serve to approximate it to the fossil which M. Ch. Lyell has made known, and consequently to the capsules of *Chara vulgaris* at present so common in the waters of numerous marshes, which exist upon the very soil filled with analogous fossil bodies. The distinction becomes so much the more difficult to be established, that in the seeds of the same species of chara gathered from the same stalk, there are perceived in the size, the more or less elongated general form, the number of spiral turns, differences which some might consider sufficient to establish several genera. M. Constant Prevost has found similar variations in the fossil gyrogonites, of which he has a great number in his possession. Most of these, as in the *G. medicaginula*, have lost their outer covering and the part preserved, or rather replaced, is only the internal nucleus of the capsule, of which, however, the impression is frequently preserved in hollows in the compact silex. These petrifactions are seen principally in blocks of white and compact fresh water silex, which affect irregular rounded forms, representing geodes, which are disseminated without order in

the midst of clay, marbled with red and bluish colours. These siliceous blocks, which are often hollow in their interior, are filled with the same clay, and with an immense quantity of *G. medicaginula*, and of the new species. In that case, the fossils are free, and it is easy to separate them from the clay by washing. The residuum obtained by this operation, appears to the naked eye to be nothing but a very fine sand; but, with the assistance of a lens, it is distinctly seen that each grain is a part or a complete mould of one of the two gyrogonites, or a broken fragment of stems, the structure of which differs in no way from that of the stems of the genus Chara. Nitric acid produces no effect upon these parts, which renders it probable that they have been transformed into silex. When nitric acid is poured upon the dried, and even the fresh, capsules of recent chara, it causes a lively effervescence, produced by the decomposition of a great quantity of carbonate of lime, which is contained in the outer envelope of the capsule, as well as in the stems. This effervescence destroys the opaque part of the envelope; and the nucleus, which is almost, in every respect, similar to those that have become fossil, remains untouched in the liquid. It ought to be remarked, on this occasion, that, in the calcareous rocks which contain fossil gyrogonites, it is the outer envelope that has been preserved, while the nucleus has disappeared,—a result the reverse of what the siliceous rocks disclose.

M. C. Prevost found the same gyrogonite in the fresh-water flints of Nogent le Rotrou, which were given him by M. J Desnoyers, who has also some specimens of a greenish compact limestone, resembling, in its mineralogical appearance, some beds of Jura limestone, of the Department de la Manche; in which country the specimens were found in digging wells. They contain a globular gyrogonite, which differs, in some points, from the *G. medicaginula*. Some fresh-water marls of the vicinity of Epernay, collected by M. Deshayes, are filled with gyrogonites which are also globular, but less perfectly so, and larger than the *G. medicaginula*, and, perhaps, similar to those already pointed out by M. Bigot de Morogues. There has also been observed in the deposits, superior to the Fountainbleau sandstone, above Valvin, a constant variety of elongated gyro-

gonite, larger than that which forms the principal object of the present notice. If, to all these indications, there be added the description of *tubercular gyrogonite*, discovered by Mr Charles Lyell in the Isle of Wight, it will be seen that the genus of fossil Chara is an object of much interest to the botanist and geologist. There remain, without doubt, many fossil species to be discovered, but it is of importance that the gyrogonites receive specific names only after a preliminary examination of the Chara, at present existing, may have fixed the limit of the possible differences in the capsules of the same plant, and determined the value of the parts which are capable of furnishing distinctive characters. This philosophical object cannot be better attained than by the naturalist who first discovered the existence of fossil Charæ; and the circumstance, that M. Leman is at present occupied with a work on the subject, prevents the author of this notice from bestowing a new name upon the gyrogonite which he imagines he was the first to observe

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Notice regarding Fossil Remains found in Ava.

THE Calcutta Government Gazette contains the following account of the fossil remains brought to Calcutta, on account of Government, from the Burm e Empire, by the late mission to Ava.

"Of the fossil bones, the most numerous and remarkable are those of an animal about the size of a large elephant, stated to be the bones of the mammoth. This is a mistake. The mammoth is an extinct species of the elephant, differing from the two living species, the African and Indian. The remains of this animal have only been found in Europe, and chiefly in Siberia. The Burman fossil bones are unquestionably those of the mastodon, as may be clearly seen, by comparing, as I have done, the grinders with those of the Indian elephant, as well as the accurate descriptions and representations of both in the work of Cuvier. In the different species of elephants, the crown of the molares, or grinders, is marked by superficial transverse bands. In the mastodon, the form is widely different, the crown being marked

by deep transverse furrows and ridges, the latter divided into two or more obtuse pyramidal points or mammillæ.

It was this singular appearance which made the mastodon a long time be considered erroneously as a carnivorous animal. Five species of the genus mastodon are supposed by Cuvier to have been discovered, and I imagine the bones now under consideration will be found to constitute a sixth species; for the molares, on which he principally rests for his specific distinctions, differ very materially from the representations which he has given of the ascertained species. The mastodon of Ava, if it be a distinct species, will be found equal in size to the great mastodon of the Ohio, which is reckoned to be equal in size to the Indian elephant. A grinder, which I examined, measures, in circumference, between sixteen and seventeen inches, and the circumference of a humerus round the condyles is not less than twenty-five inches. Several of the grinders and bones, however, apparently of an animal of the same species, are much smaller than these, but this is probably on account of their belonging to younger individuals. I need hardly observe that our mastodon, like others of the same genus, and all the species of the elephant, had tusks. Several fragments, but no entire tusks, are in the collection.

"The next most remarkable remains are those of the fossil rhinoceros. There are several molares of an animal of this genus in the collection. Cuvier describes four species of the fossil rhinoceros to have been ascertained, all differing from the living species. The bones, now found, bear a striking resemblance to one of the species represented by Cuvier; but the molares are considerably larger than any of those which he has represented. The collection seems to me to afford evidence of the existence of two other animals of the same family with the elephant, mastodon and rhinoceros; at least, teeth, which I have seen in it, exactly resemble two species of a genus represented in the work of Cuvier, and to which he gives the name of *Anthracotherium*.

"The other teeth of quadrupeds which exist, and which I am able to recognise, are those of an animal of the horse-kind, and those of an animal of the ruminant family, apparently of the size of the buffalo.

"Among the remains are numerous specimens of those of a

crocodile, which I conjecture to resemble the long-nosed alligator of the Ganges, the native name of which has been corrupted by naturalists into *Gavial.* It is singular that this description of alligator, as far as we know, is not at present found in the rivers of Ava.

In the same situation with the bones were found considerable quantities of fossil shells. Some of these were filled with blue clay, but far the greater number with hard siliceous matter. The shells which I have seen are of the genus *Turbo* and genus *Tellina* *, and the productions of fresh water, although they do not, at the same time, resemble the present shells of the lakes and rivers of the neighbourhood.

The fossil wood is found in the same situation with the bones and shells. This is in vast quantity, the hills and ravines being strewed with blocks and fragments of various sizes, some of them five and six feet in circumference.

The fossil remains now enumerated are found on the left bank of the Irawadi, and within four and six miles inland from the river, between the twentieth and twenty-first degrees of north latitude, and close to the celebrated wells of Petroleum. The aspect of the country is very remarkable. It is composed of sand hills and narrow ravines, very sterile, and, for a tropical country, very deficient in vegetation. Among the sand there are beds of gravel, with iron-stone and calcareous breccia. The whole is evidently a diluvial formation. The few scattered trees which exist in this tract, consist of some *Acacias*, a *Celtis*, a *Rhus*, a *Barringtonia*, a *Zizyphus*, and some Indian fig trees. To say whether or not the fossil timber found belongs to the same species as these, would be a matter of difficulty: but, upon the whole, it may be said that the blocks appear too large to warrant a belief that it does.

The fossil bones, as well as the shells and wood, are all found superficially, or rather indeed upon the surface, for all of them were more or less exposed. Notwithstanding this exposure, they have suffered very little decomposition. They are not rolled, nor have they suffered from attrition, for their sharp edges and processes are preserved with great distinctness; the inference from which is, that the individuals to which they be-

* Probably of the genera *Cyclostoma* and *Cyclas.*—Ed.

longed died, or were destroyed, on the spot on which they are now found. In one respect the bones differ essentially from all fossil bones of which I have heard. They are complete petrifactions, and all of them more or less deeply coloured with iron. Their substance is siliceous, and some of them are so hard as to strike fire with steel. This no doubt accounts, in a good measure, for their perfect state of preservation.

The wild quadrupeds of the neighbourhood, at present, are a species of leopard, cat, deer, and the hog. The bones of these do not seem to exist among the fossil remains, nor is there any evidence of those of the elephant, or of any carnivorous animal. As amongst similar remains in other parts of the world, not a vestige is to be discovered here of the human skeleton.

I need hardly attempt the refutation of the idle notion which has been entertained by many, that the fossil remains found on the banks of the Irawadi have been generated by a petrifying quality in the water of that river. Abundance of organic matter may be seen on the shores of the Irawadi, both animal and vegetable, undergoing the common process of decomposition as elsewhere. There can, I think, be no doubt that the fossil bones, shells, and wood, are here, as similar remains are admitted to be elsewhere, all the result of the last, or one of the last, great catastrophes which changed the face of the present globe. They are, in fact, the remains of a former state of our world, when the greater number of the present races of animals had no existence, and, above all, before man was called into existence.

The collection is altogether both extensive and curious, and the more worthy of attention, since it is, as far as I am aware, the first of any moment that has ever been discovered in the East.

Report made to the Royal Academy of Sciences of Paris, upon a Memoir by M. Constant Prévost, entitled An Examination of the Geological Question, whether the Continents which we inhabit have been repeatedly submersed by the Sea. By Mess. Cuvier & Cordier.

The author, in the first place, endeavours to prove, that, among the sedimentary and alluvial formations, there is no bed

that could be considered as representing an old continental surface, that might have been long covered with terrestrial vegetables, and inhabited by land animals, before being enveloped by marine deposits. He shews, that he has in vain sought the traces of old continental surfaces in contact with the marine and fresh water formations, which alternate in several parts of France, Germany, and England. He unfolds the reasons for thinking that the remains of vegetables, which are sometimes found in a vertical position in sandstone of the coal formation, owe this position only to chance. The presence of remains of mammifera, whether in the diluvian strata properly so called, or in caves anterior to these strata, appears to him to afford no better evidence that the sea has overwhelmed a soil previously inhabited; and he ultimately arrives at the conclusion, that the countries which are occupied by alluvial and sedimentary deposits, were covered by the waters during the whole time that these deposits required for their formation.

The author then carefully enumerates the principal circumstances which characterize the formation of the deposits which take place in our own days in lakes, at the mouths of rivers, on the shores of the ocean, and in all the parts of its basin which have little depth. Among these deposits, he distinguishes those which result from more or less rapid currents, and those which proceed from quiet precipitations; those which belong to the shores, and those formed in the open sea. He calls to mind the fact, that rivers frequently carry out to great distances continental organic remains of all descriptions, and that the waters of the sea, accidentally raised from their basin, sometimes make momentary irruptions over surfaces of great extent, which are commonly occupied by marshes, lagoons, and lakes, the bottom of which is incontestably formed by deposits filled with fluviatile and terrestrial organic remains. He makes various remarks upon the nature of the mollusca, which live isolated or in families, near the shores, or at a distance from them. Lastly, he shews, that, by the concurrence of presently existing causes, the English Channel (La Manche) ought to contain alternations of strata analogous to those which constitute the lower part of many tertiary formations; that were the level of the sea lowered twenty-five fathoms, this strait would be changed into a vast lake; and that

after a certain lapse of time, there would necessarily be formed a series of strata analogous to those which occur in the upper part of the same deposits of various countries.

Proceeding from these data, and supposing, in general, that the level of the sea has actually undergone a slow and progressive lowering from the origin of things, the author undertakes to explain the manner in which the tertiary deposits of the neighbourhood of Paris have been formed, as well as those which constitute their continuation, whether extending to the Loire, or across the Channel in the neighbourhood of the Isle of Wight. Considering all these deposits as belonging to an ancient basin, he represents their constitution by means of two transverse sections, in which he has brought together all the observations that have hitherto been collected, and which afford a precise idea of the alternations, mixtures, and entanglements which the various deposits present. The author is of opinion that these sections are sufficient, with the aid of the explanations annexed, to shew that marine strata of chalk, coarse limestone, marls, and superior sandstones, have been formed in the same basin, and under the same waters, as the plastic clay, the siliceous limestone, and the gypsum itself, which essentially contain remains of terrestrial and fluviatile animals and vegetables; but he does not fail to add to his system of explanation, all the details and inductions which appear to him calculated to insure probability. The following is a brief statement of his views.

First Epoch.—A calm and deep sea deposits the two varieties of chalk which constitute the sides and bottom of the great tertiary basin in question.

Second Epoch.—In consequence of the progressive lowering of the ocean, the great basin becomes a gulf, in which matters carried down by the rivers form chalky brecciæ and plastic clay, are soon covered by the marine spoils of the first coarse limestone.

Third Epoch.—The deposits are interrupted by a commotion which breaks and sensibly displaces the strata. The basin becomes a salt lake, traversed by voluminous currents of water coming alternately from the sea and the continents, and which produce the mixtures and entanglements presented by the se-

cond coarse limestone, the siliceous limestone, and the gypsum deposits.

Fourth Epoch.—Irruption of a great quantity of fresh water, charged with clays and marls, in the midst of which there are still found some deposits of marine bivalve shells. The basin is now only an immense brackish pool.

Fifth Epoch.—The basin ceases to communicate with the ocean, and the level of its waters falls below that of the waters of the sea. The muddy deposits of the continental waters continue.

Sixth Epoch.—Accidental irruption of the ocean, which deposits sands and the upper marine sandstones. Immediately after, the basin, nearly filled up, contains only fresh water of little depth; it receives fewer streams; vegetables and animals are established in it; the buhrstones and the fresh water limestone are deposited.

Seventh and *Last Epoch.*—The succession of these various operations is terminated by the diluvian cataclysm.

From the preceding analysis, it will be seen that the object of M. Prevost's memoir is not to make known new facts, but to bring together a great number of curious facts, to discuss their characters, to determine their influence, to compare those which appear capable of comparison, and to endeavour to get at the causes by means of certain suppositions which may be more or less probable. Attempts of this kind have certainly their importance and their utility in geology; they present, however, great difficulties, and we ought to be the more indulgent to M. Prevost for having engaged in them, that he has done so with remarkable ingenuity. We have therefore the honour of proposing to the Academy that his memoir be printed in the Recueil des Savans Etrangers.

On the History and Constitution of Benefit or Friendly Societies. By Mr W. Fraser, Edinburgh. Continued from p. 296 of former Volume.

In the preceding Number of this Journal a summary was given of the investigations of the Highland Society of Scotland, and of a Select Committee of the House of Commons in 1825, into the

average rate or Law of Sickness among mankind, as deduced from the experience of numerous Friendly Societies in Scotland, and from the Monthly Reports of the whole army quartered in Britain during the years 1823 and 1824. It was likewise stated, that another Select Committee had been appointed by the House of Commons in 1827 to make farther inquiries into the same subject, and other matters connected with Health and Life Assurance. The Report of this latter Committee was presented to the House at the close of the last session of Parliament, and, along with the Minutes of Evidence on which it was founded, ordered to be printed. This interesting document contains much additional information on subjects of the utmost importance to all classes of the community; a brief detail of which shall be given in the following pages

The Report commences with stating, that the Committee of 1825 having entered minutely into all matters connected with Friendly Societies, the Committee of 1827 have not gone into any farther investigation as to sickness, but have chiefly confined their attention to those points upon which the former Committee had come to no conclusion. The opinion, however, of Messrs Finlaison and Davies, two eminent actuaries, was requested as to the proper contribution required for a given benefit during sickness; and these gentlemen accordingly gave in a report, exhibiting in a very brief form, all that is essentially necessary for securing the stability of such societies as limit their benefits to allowances during sickness, in old age, and at death These comprehensive rules, which the Committee have recommended for general use, will be given when we come to treat of the rates of contributions and benefits; but it may here be observed, that, in giving their opinion, these actuaries had no other materials from which to calculate the probable rate of sickness, than those which had been before the Committee of 1825. Their data, therefore, consisted of a rate of sickness assumed by Dr Price—of that deduced by the Highland Society from the experience of numerous Friendly Societies in Scotland—of the rate assumed by the Reverend Mr Becher of Southwell, in Nottinghamshire,—and of that found to prevail in the army from the official returns at the Adjutant-General's Office. This latter rate, however, we formerly remarked, could not, for the

reasons then assigned, be applicable to the members of Friendly Societies; and it appears that Messrs Finlaison and Davies are now of the same opinion, for they state, " that this is a rate of sickness which certainly exceeds all estimate of what has hitherto prevailed among the labouring classes, and arises, no doubt, from causes to which the members of friendly societies in general would not be subject." But these gentlemen also state it to be their opinion, that the rate of sickness reported to the Highland Society falls short of the proportion that would be experienced in the practice of Friendly Societies in England, in the same degree that the sickness of the army is excessive; and they have therefore taken a mean between the two, in calculating their rate of contribution for benefit during sickness. As, however, this mean is, under 50 years of age, double that reported by more than 70 Friendly Societies in Scotland, comprising upwards of 100,000 members,—and, as no reason whatever is given by these gentlemen why the rate of sickness should be so very much higher among the same classes in England, the accuracy of their conclusion may at least be doubted. At all events, as no additional information has been obtained on this subject by the last Committee, we cannot but still adhere to our former opinion,—that the law of sickness deduced by the Highland Society of Scotland is the most satisfactorily authenticated of any yet published.

Law of Mortality.

The next, and perhaps the most important, question that falls to be considered, is that regarding the rate or Law of Mortality.

Tables of Mortality, it is well known, are intended to shew how many persons, out of a given number at any age, may be expected to survive to a higher age; and, consequently, these tables form the basis of all calculations for Health and Life Assurance. Such tables have been hitherto formed from registers of mortality, which usually include the marriages and births, as well as burials—from bodies of annuitants—and from actual surveys or enumerations of the proportion of deaths among persons living at the same ages in countries and in towns.

Mortuary registers were begun to be kept in Germany about the end of the 15th century; and, in 1538, the incumbent of every parish in England was ordered, by the Privy Council, to keep an exact account of all the weddings, christenings, and burials within his district. This duty, however, seems to have been for a long time very ill discharged; and it was not till about 1690, that the ages were first inserted in the bills kept at Breslaw in Silesia, and not till 1728, in those kept at London. In 1749 the government of Sweden " established what in this country would probably be called a Board of Population, but is there denominated *Tabelvaket*, for reducing into convenient forms the extracts from the parish registers, and the returns from the magis-

trates of the numbers of the people, which the governors of the different provinces are required to state to the commissioners appointed for these purposes. The extracts from the registers are made and transmitted annually, but the enumerations only once in three years. Printed forms, with proper blanks, distinguishing the ages and sexes, both of the living and the dead, with the diseases the deaths were occasioned by, are distributed throughout the country to enable the people to make these returns correctly and uniformly; and the information thus acquired, respecting the state of population and mortality, is much more correct and satisfactory than what has been obtained in any other place of considerable extent."*

The first table of mortality was constructed by Dr Halley from the register kept at Breslaw for the five years ending with 1691; and Mr William Kersseboom of the Hague, published a tract in 1742, in which he gave a table of mortality formed from registers, kept for nearly 130 years, of many thousand life annuitants in Holland and West Friesland. Mr Nicholas Struyck also published at Amsterdam, about the same time, two tables of mortality from registers of annuitants kept there for about 35 years,—one of these tables shewing the mortality of females, and the other that of males, but both, when combined, agreeing very nearly with the table of Dr Halley. In 1742, likewise, Mr Thomas Simpson gave a table of mortality for London; and in 1746, M. Deparcieux published an essay at Paris, in which he inserted six new and valuable tables of mortality, one of them constructed from the lists of the nominees of the French Tontines, principally for the years 1689 and 1696, and the others from the mortuary registers of various religious houses in France. Four of these shewed the mortality of the monks of different orders, and the fifth that among the nuns of different convents in Paris. Dr Price, in the first edition of his Observations on Reversionary Payments, published in 1771, gave three new tables of mortality, constructed from the London, Norwich, and Northampton bills; and in his second edition in 1772, five other tables, likewise new, for various places on the Continent and in England. In his fourth edition, which appeared in 1783, he gave some other new tables of mortality, for Warrington and Chester; likewise for all Sweden and Finland, and for Stockholm separately, in which the sexes were distinguished These latter tables for Sweden and Finland, were the first which had been constructed from data that could be relied on, being enumerations made at seven different periods, of the living, and registers of the annual deaths, in each interval of age, among the whole population for 21 years ending 1776, (Stockholm excepted, it being for 9 years only) and the materials for which had been communicated to him by M. Wargentin, one of the Commissioners of the Tabelvarket. In 1806 M. Duvillard published a work at Paris on the Influence of the Small Pox on Human Mortality, in which he gave a table of mortality for France, founded on observations made from extensive materials collected previous to the French Revolution. Mr Joshua Milne, in his Treatise on Annuities and Insurance, published in 1815, likewise gave two new Swedish Tables of mortality, exhibiting that of the sexes both separately and together, and deduced from the Swedish observations for the 25 years ending with 1795. He also furnished a table constructed from very accurate observations made at Carlisle upon a mean number of 8177 persons of various ages, ranks, and conditions, by Dr Heysham, who, for the 9 years from 1779 to 1787, carefully preserved the bills of mortality of that city, supplied their deficiencies, and kept correct accounts of two enumerations of the people, in which their ages were taken. And, lastly, Mr Milne gave another table of mortality from the Swedish Observations for the 5 years ending in 1805, in his article on the Law of Human Mortality inserted in the volume of the Supplement to the Encyclopædia Britannica published in 1824.

Such were the principal tables of mortality up to this latter date; but the one which had been for a long period almost uniformly relied on for practical purposes in this country, was that denominated the Northampton Table, constructed by Dr Price from the mortuary registers of that town for 46 years ending with 1780. A pretty general opinion, however, had for many years prevailed, that this table exhibited the rate of mortality much higher than what

* Supplement to Encyclopædia Britannica, art. Bills of Mortality

actually occurred, but of this no perfectly satisfactory evidence had, till lately, been obtained. The three Swedish Tables, although perhaps not applicable to this country, were always acknowledged to be formed from the most correct data, being founded upon observations neither confined to a short period of time nor to a small extent of territory. The two latter of these tables exhibit an increased duration of life in that country; and all the three represent the rate of mortality there as being much less than that shewn by the Northampton Table. Although the Carlisle Table gives a still lower rate than the Swedish, yet, as the observations from which it had been deduced were more complete than any which had previously existed in Britain, this table was thought by many to exhibit more accurately than any other the duration of human life in this kingdom.

The difference of mortality in the sexes, and also the disproportion of male and female births, were found by Dr Price, from very extensive investigations, to be as follows:

According to the registers of several large towns in Germany, it appeared that the still-born males and females were as three of the former to two of the latter; and from a very extensive collection of facts derived from the registers of various places, both in this country and on the Continent, it was ascertained that there were also more males every where born alive than females,—the total number of males born in those places, during certain periods, being 2,388,950, and that of females 2,271,201, or in the proportion of 20 to 19; and throughout France, in the ratio of 18 to 17. But from equally satisfactory observations, it was likewise ascertained, that, from some peculiarity inimical to life in the male constitution, the males were reduced to a lesser number than the females before the expiration of the first year of age. In some situations also, more than a half, and in others more than a third or fourth, of both males and females were found to die before the fifth year of age.

In large towns, the births were fewer, in proportion to the marriages, than in the country; and the mortality was so great, especially among children, that had it not been for a continual influx from the country, the population of large towns would have rapidly decreased.

The mortality of males continues to be greater at all ages, throughout the whole period of life, than that of females,—the difference being, in Dr Price's time, least in the whole kingdom of Sweden, greater at Chester, and greatest at Stockholm. The number of deaths or "decrements among males, increase regularly through every period of life, from 10 to 75; but among *females*, this increase is interrupted for a few years after 45. This cannot be an accidental irregularity, the numbers being too great, and the period for which the observations have been made too long, to admit of such an irregularity. Probably, therefore, it must be accounted for in the following manner. From the age of 30 to 35, the number of married, and consequently of child-bearing women, is greater than at any other ages; and this raises the decrements in that division of life. After 35, this number is diminished, and the decrements fall. Between 40 and 45, the critical periods come on, and the decrements are raised again; but after 45, the number of deaths arising from hence becoming less, the decrements become also less, but continue afterwards to increase, with increasing years, till they become greatest at 74 or 75. It is, however, remarkable, that notwithstanding the peculiar dangers to which the lives of females are subjected, from the causes just mentioned, there are no ages at which a *smaller* proportion of them does not die than of males, except the ages in which the number of deliveries is greatest, and that even *then* the probabilities of living among them are nearly equal to those among males*." It may likewise be mentioned, that females are found to live, upon an average, from 3 to 4 years longer than males; and married women longer than unmarried.

But however accurately the rate of male and female mortality may be deduced from observations made among the population at large, it must be evident that such a rate will not correspond with the experience of Life Assurance Societies, whose members must be all in good health at the period of their admission. Accordingly, in almost every such society, the actual number of deaths among

* Price on Reversionary Payments, vol. ii. p. 408, 7th Edit. 1812.

their members, for the first 10 years at least after entry, fall greatly short of that represented by the tables of mortality; and, of course, this difference will be the greater, the more incorrectly any table in use may represent the average rate of mortality among mankind to be. Thus, in the Equitable Assurance Company of London, whose premiums are regulated by the Northampton Table, it was ascertained by Mr Morgan, the eminent actuary of that association, upon a calculation for 30 years, ending with 1810, and upon 83,201 members, that the mortality which had occurred was only to the claims which might have been expected, from the age of 20 to 30 as 1 to 2; 30 to 40 as 3 to 5; 40 to 50 as 3 to 5; 50 to 60 as 5 to 7; 60 to 80 as 4 to 5, and in all ages together, in the ratio of 2 to 3.

Any rates of contributions, therefore, calculated from the Northampton Table for sums payable at death, must be necessarily more than adequate to defray these benefits, and hence the principal source of the large surpluses or profits that are always realised upon those assurances. Indeed, according to the above experience, the premiums charged by the Equitable, and, till lately, by all the other offices, for sums payable at death, are 30 per cent. higher, and in many cases more, than are necessary to provide for the sums assured.

In the case of annuities, however, calculated from the Northampton Table, the effect is generally the reverse; for, as none will purchase these benefits but those who are in the best state of health, and of strong constitutions, it has usually been found that they live, on an average, considerably beyond the time expected. Comparatively few offices, therefore, have schemes for annuities, and such as do insure these benefits, generally purchase them from government, which is now ascertained to be losing considerably every year by such transactions.

While, therefore, the premiums for annuities calculated by the Northampton Table have been found greatly insufficient, the premiums for sums payable at death have been as much in excess; and as the great mass of assurances consists of this latter benefit, such excess had become an oppressive and unjust tax on the higher classes of the public.

But inaccurate mortality tables must, if possible, prove still more hurtful to Friendly Societies, than even to the higher classes of mutual assurance associations; for, on the one hand, the members of those societies are ill able to pay more than is necessarily required, while, on the other, an inadequate contribution would prove ruinous in the extreme. Hence an accurate table of mortality is of the utmost importance in the computation of their rates of contributions and allowances; and it therefore became a serious question, first with the Committee of the Highland Society of Scotland, and next with those of the House of Commons, what table of mortality ought to be adopted.

The Highland Society confined their inquiry among Friendly Societies to age and sickness only; but this they afterwards regretted, as it was found that the mortality of their members might have been also pretty accurately obtained. As already mentioned, the committee had therefore to consider what tables of mortality could best be relied on, and applied for the opinion of several eminent calculators on the subject. Among many communications which were in consequence received, the following are extracts from one made by Dr Hamilton of Aberdeen.

"The choice of proper tables for ascertaining the rate of mortality, is a point of the greatest importance. I have not seen Mr Milne's Treatise on Annuities, containing the Carlisle Tables, but observe that they give the probabilities of life higher than any tables I am acquainted with. The Swedish Tables, given by Dr Price, are also high, and give an intermediate result between the Northampton and Carlisle Tables. I think the calculations should not proceed upon one set of tables only, but upon the medium of several esteemed the best. Perhaps the three above mentioned (Northampton, Swedish, and Carlisle), are as good as any we are at present in possession of. I consider it, however, as a *desideratum* to obtain tables founded upon more recent observations than those which we at present use, which, with the exception of the Carlisle one, are founded upon bills of mortality kept long ago."—"Now, it is generally believed that there has been a sensible increase in the duration of human life in this and other civilized countries, within the last half century,

which may be accounted for from more cleanly habits, the better treatment of diseases among the poor, the practice of vaccination, &c. The belief of this is so prevalent, that some of the insurance offices have altered their terms; and the Carlisle tables seem to confirm the opinion. The effect of an increase of longevity is to *increase* the value of an annuity for life; to *lower* the terms upon which insurance for life may be effected; to *ameliorate* the terms for annuities to widows; but it *increases* the demands upon Friendly Societies for the relief of sickness and old age."—"Although the possession of more tables, founded upon recent observations, is to be desired, we must, in any present scheme, make the best of those we have *."

Accordingly, upon considering various tables of mortality, and after the most mature deliberation, it was resolved to found the computations upon a medium derived from the Northampton, Carlisle, and latest Swedish tables; and, from such data, Mr John Lyon, now one of the masters of the High School, Leith, and an able calculator, constructed a new table of mortality. In the formation of this table, Mr Lyon reduced the three tables, of which it is an average, to the same *radix*, or number, at the completion of 20 years of age (it being only after that age that such tables are chiefly useful, at least for Friendly Societies); added the corresponding numbers together, and assumed 1005 as the radix for a new table, using the nearest whole numbers to avoid fractions. Before, however, giving this table, it may not be superfluous to contrast those tables from which it has been deduced, in decades, or periods of ten years, by which means some idea will be formed of the propriety of the rate of mortality adopted. According to those three tables, then, the proportion of the deaths to the living, at different ages, is as follows:

Ages.	Northampton.	Carlisle.	Latest Swedish.
Between 20 and 30	1 to 63.7	1 to 132.60	1 to 134.86
30 — 40	1 — 53.5	1 — 94.44	1 — 102.96
40 — 50	1 — 41.7	1 — 69.72	1 — 70.07
50 — 60	1 — 29.9	1 — 54.74	1 — 39.81
60 — 70	1 — 20 3	1 — 24.24	1 — 20.43
70 — 80	1 — 11.0	1 — 12.04	1 — 8 95
80 — 90	1 — 5.0	1 — 5.69	1 — 4.30
Above 90	1 — 2.4	1 — 3.50	1 — 2.38

Thus it appears that the Northampton Table represents the rate of mortality, in the earlier ages, to be double that represented by the Carlisle; 1 out of 63 persons, of any age between 20 and 30, dying annually according to the former table, while there is only 1 out of 132 according to the latter. The following is the average of the three, and also the average of the number of the living to those who died at the same ages in the city of Glasgow, as correctly ascertained by Mr Cleland, during the year 1822, the one succeeding that in which the last census was taken, and in which the number of deaths differed only by four from that of the preceding year. The table of the Highland Society represents the average rate of males and females combined.

Ages.	Highland Society Average.	Glasgow.		
		Males.	Females.	Both.
Between 20 and 30	1 to 95.50	1 to 81.5	1 to 137.5	1 to 107.5
30 — 40	1 — 76.67	1 — 73.5	1 — 81.1	1 — 77.5
40 — 50	1 — 58.14	1 — 58.7	1 — 74.2	1 — 66.0
50 — 60	1 — 40.28	1 — 41.5	1 — 47.5	1 — 44.6
60 — 70	1 — 21.90	1 — 20.7	1 — 23.6	1 — 22.3
70 — 80	1 — 10.48	1 — 8.1	1 — 9.6	1 — 8.9
80 — 90	1 — 5.17	1 — 5.9	1 — 6.6	1 — 6.3
Above 90	1 — 2.50	1 — 1.6	1 — 2.9	1 — 2.4

* Highland Society's Report on Benefit or Friendly Societies, p. 53. Edin. 1824.

Here the difference between male and female mortality is very strikingly shewn by the Glasgow Table,—a fact which, although well known to those accustomed to such investigations, has been hitherto seldom contemplated by the great majority of the public. But, as the average of these two tables for males and females combined, come so near to each other, in periods of ten years, being, according to the Highland Society's average for all ages between 20 and 50, one in 76.77 annually, and, according to the Glasgow observations, one in 83.66, it may be presumed that the following Table will represent pretty accurately the mortality of the working classes of this country, at all ages from that of 20 to the utmost period of life. The average number alive, throughout the year, is a mean between those alive at the beginning, and those alive at the end of each year.

" MORTALITY TABLE, exhibiting the Law of Mortality after 20 years of Age, or the Number of Persons alive at the beginning of each year, till all are dead. out of 1005, all commencing the 21st year of their age at the same time;—being an average of the Northampton, Carlisle, and latest Swedish Tables of Mortality *.

Age	Number who commence in each year.	Number who die each year.	Number alive each year on an average.	Age.	Number who commence in each year.	Number who die each year.	Number alive each year on an average.	Age.	Number who commence in each year.	Number who die each year.	Number alive each year on an average.
21	1005	10	1000	46	733	13	727	71	324	23	313
22	995	10	990	47	720	13	714	72	301	23	290
23	985	10	980	48	707	13	701	73	278	22	267
24	975	10	970	49	694	13	688	74	256	22	245
25	965	10	960	50	681	13	675	75	234	21	224
26	955	10	950	51	668	14	661	76	213	21	203
27	945	10	940	52	654	14	647	77	192	20	182
28	935	10	930	53	640	14	633	78	172	19	163
29	925	10	920	54	626	14	619	79	153	18	144
30	915	10	910	55	612	15	605	80	135	17	127
31	905	10	900	56	597	15	590	81	118	16	110
32	895	11	890	57	582	15	575	82	102	15	95
33	884	11	879	58	567	15	560	83	87	14	80
34	873	11	868	59	552	16	544	84	73	13	67
35	862	11	857	60	536	16	528	85	60	11	55
36	851	11	846	61	520	16	512	86	49	10	44
37	840	11	835	62	504	17	496	87	39	9	35
38	829	11	824	63	487	17	479	88	30	7	27
39	818	12	812	64	470	18	461	89	23	6	20
40	806	12	800	65	452	19	443	90	17	5	15
41	794	12	788	66	433	20	423	91	12	4	10
42	782	12	776	67	413	21	403	92	8	3	7
43	770	12	764	68	392	22	381	93	5	2	4
44	758	12	752	69	370	23	359	94	3	2	2
45	746	13	740	70	347	23	336	95	1	1	1

Such, then, was the rate of mortality adopted by the Highland Society of Scotland in calculating the necessary contributions for allowances in Sickness, Deferred Annuities, and sums payable at Death, to the Members of Friendly Societies; and it will next be seen from the evidence taken before the two Select Committees of the House of Commons, how far the above Table may be considered as suitable for these purposes.

* Highland Society's Report, p. 146.

Report of Parliamentary Committee in 1825.

The causes which led to the appointment of this Committee, and the result of their inquiries into the rate of sickness, have been already detailed. As to the law of mortality, comparatively little information was obtained, except that afforded by Mr John Finlaison, actuary to the National Debt Office, from the experience of the Government annuitants. The following extracts contain all that is important in the Minutes of Evidence on this subject.

1825, *March* 8.—The *Rev. J. T. Becher* of Southwell in Nottinghamshire, gave it as his opinion, that no greater approach to accuracy in the rate of mortality can or need be made, than what is made by the Northampton Tables.—*Report*, p. 29.

John Finlaison, Esq. Actuary to the National Debt Office, stated, That, six years ago he had been appointed by Government to investigate the true law of mortality which prevails in England, among persons of either sex, at the present time,—at the present time, he says, because he had discovered a very extraordinary prolongation of life in the course of the last hundred years. He had thus been enabled to make observations upon nearly 25,000 life-annuitants of both sexes, consisting of the nominees in the three Tontines commenced in Ireland between 1773 and 1779; the nominees of the great Tontine commenced in the year 1789, in England; and the nominees of Life Annuities granted at the National Debt Office since the year 1808.—From which observations it appeared that the duration of existence now, compared with what it was a century ago, is as four to three in round numbers; but that the difference in the duration of male and female life is much the same as it had been stated by former authors. (See p. 73. *of this Journal.*) These Life Annuitants, of course, chiefly consisted of the upper classes; but Mr Finlaison had also been enabled, by the orders of Government, to observe the law of mortality prevailing among 75,000 out-pensioners during the seven years between 1814 and 1822, when a very great difference was found, as might have been expected, between the mortality of these two classes, the latter being all men who had been discharged either on account of long service, wounds, or impaired constitutions. Mr Finlaison also found, that the Carlisle table came nearest to that which he had deduced from the observations of the 25,000 people, had he combined both males and females together, as had been done by the framer of the Carlisle table; but was of opinion that the data for this latter table was rather insufficient: "In reference to the Northampton tables, which are the basis of most of the calculations issued in this country, it is well known that that table underrates human life to a very great degree. I hold in my hand a calculation of the effects of the Northampton table, as applied to the nominees who have purchased annuities from the Sinking Fund within the last sixteen years; and the statement also shews the application of my own tables to the same events, both of them as compared with the fact,—the result is, that 481 of those nominees would, according to the Northampton table, have deceased beyond what the fact has been, out of 5,940; and that, by my own table, the excess that should have died beyond the fact is only 21; and we rather think that difference will vanish when we come to know the whole of the facts of the case, because several people have not claimed their annuities, who may possibly be dead." The witness, in the course of his examination, delivered to the Committee several tables in confirmation of his statements.—*Pages* 44, 45, 46.

March 15.—William Morgan, Esq., Actuary to the London Equitable Society, conceives that there is a very great difference between the mortality of the children of the lower and of the higher orders, more deaths taking place among the former than among the latter class; and that he is sure not half the children born in London live to be four years of age.—*Page* 52.

April 28.—*William Frend*, Esq. Actuary to the Rock Life Assurance Institution, thinks the Northampton table would come nearer to the average of

life among the members of Friendly Societies than they would do among the higher classes; but does not think that there is any difference in the duration of human life since the time when the Northampton tables were framed.—*Page* 87.

Dr Augustus Bozzie Granville, professionally connected with two extensive lying-in institutions, and with the Infirmary for Sick Children, gave some valuable and interesting information as to the earliest ages at which women marry,—the period they are most prolific, and when they cease to bear children,—the average number of still-born and living children to each marriage,—the periods of infant life when the greatest mortality prevails, &c. "The numbers of married women, to whom my observation has extended, as far as the statements in the books before the Committee bear me out, are 7,060 at the Westminster General Dispensary in seven years and a quarter; 2,755 in three years at the Benevolent Institution; and, in reference to the children at both these institutions 9,000; while at the Royal Infirmary for Sick Children, 5,640 is the number as stated before; giving a general total of observations, amounting to 24,450." We must delay till a future opportunity a full detail of the results of Dr Granville's investigations; but he states that, in 1818, "I made a calculation referable to about 400 women, whom I had closely questioned respecting miscarriages they might have had; the results which that examination gave me was, that, among the class of the poor, 1 woman in 3 who is pregnant invariably miscarries. After a lapse of seven years, I picked out, without reference to age, or any thing else, 840 other women, attendant on another medical charity under my care, different from that which had supplied the number obtained seven years before; and, on calculating from their answers to the same question respecting miscarriage, the results of those answers, I found that, in both institutions, though the poor are resident in different parts of the town, but of the same class in life, precisely the same proportion resulted from the calculation, viz. that 1 in 3 miscarried, passing over the number of women who might have been examined during the intermediate period of seven years on the same subject."—*Pages* 84, 85.

May 4.—*Mr John Finlaison* having on a former day received the books of Dr Granville, with a view to calculating results that might be useful for the purposes of the Committee, he now gave in a paper containing these results, as calculated from a careful analysis of those registers. Whence "it appears that the mortality among infant life, in the class of poor people, is very great, so much so, that out of every 1000 births, only 542 infants survive the period of nursing, or, in other words, are alive at the time of the mother's next lying-in. It appears further, that, for whatever period child-bearing goes on among the lower classes in London; up to the twentieth year of parturition inclusive, the number of births are invariably constant at the rate of two in four years; while the number of children reared and alive at the period of the mother's next lying-in, is also invariably constant at the ratio of one in every four years."—"It does not appear that any material observation results from the age at which marriage is contracted on the side of the female, with this exception, that, when marriage is formed very young, the births are not so quick as when marriage is formed at maturer years. For example, while 400 females, married under 17, would, in each year, from the period of parturition, have 182 births; 400 females, married between 28 and 33, would have 236 births, because these last happened in the earlier years of marriage; but the proportion of children which the one and the other class would be able to rear, would be just the same."—It is added, that these observations apply exclusively to the lower orders in London, from which class the registers were framed.—*Page* 90.

Such was the principal information obtained by the Committee of 1825, relative to the births and mortality of this country; but it is proper to remark, that these subjects did not form a primary object of this inquiry—endowments for children, the average rate of sickness, and the more minute details of the management of Friendly Societies, being the points which the Committee

had principally in view. They stated, however, in their Report, that "it is certain that the experience of the offices for insurance on lives has proved the Northampton Tables to be much more unfavourable to human life than the purposes of those offices require;" and recommended to the House to resume their inquiry in another session, that such information might be obtained, under parliamentary authority, as should place the question almost beyond controversy.

Report of Parliamentary Committee in 1827.

The attention of this Committee was chiefly directed to the Superannuation Allowances of Friendly Societies, and consequently to the average duration of life, on which all computations for such allowances must necessarily depend. It was therefore indispensably requisite, that the history and accuracy of the Northampton Tables should be more particularly considered than they had been by the former Committee; and that this has accordingly been done, will appear from the following brief summary of the Minutes of Evidence.

April 3. 1827.—The *Reverend J. T. Becher* gives a detail of his investigations into various tables of mortality, and of the different mortuary registers from which Dr Price had deduced the observations on which he constructed the Northampton Tables. From such a concurrence of testimony as "was brought under the consideration of Dr Price, when he originally formed the Northampton Tables, I venture to presume that they were then rendered as correct as calculations founded upon the doctrine of such chances could avail; and consequently that they still remain sufficient for every practical purpose, unless some variation can be shewn in the ordinary standard of mortality."—"In a note published by Mr Morgan upon Dr Price's Observations on Reversionary Payments, he states the mortality prevailing among the members of the Equitable, or the proportions subsisting between the claims that had been actually made, and the claims that should have been made, according to the Northampton calculations: which statement of Mr Morgan has, as I conceive, given rise to considerable misapprehension and error. Subsequent calculations have been made by Mr Babbage, an eminent mathematician, and by Mr Griffith Davies, an intelligent actuary of the Guardian Office. Both of them have formed tables upon what they denominate the experience of the Equitable, meaning the experience of Mr Morgan, as communicated to the public in the few lines which they cite as their basis. Now, in the year 1777, it will be found in the Journals of the House of Commons, that when Mr Morgan gave evidence before the Usury Committee, he stated the claims made upon the Equitable to be to those which should have been made, in the following proportion," Table I. "And in the year 1810, Mr Morgan made a calculation for 30 years, upon 83,201 members of the Equitable, from which he deduced, that the mortality which had occurred was to the claims which might have been made," as in Table II.

TABLE I.

From	20 to 30 as 7 to 17
	30 to 40 as 3 to 5
	40 to 50 as 1 to 2
	50 to 60 as 7 to 5
And in all ages from	20 to 70 as 2 to 3 nearly.

TABLE II.

From	20 to 30 as 1 to 2
	30 to 40 as 3 to 5
	30 to 50 as 3 to 5
	50 to 60 as 5 to 7
	60 to 80 as 4 to 5

And in all ages together, in the ratio of 2 to 3.

"Here we find subsisting between the sums a singular correspondence. From 30 to 40, and 40 to 50, the proportions are precisely the same, and at all other ages nearly so; and the general ratio in both instances is as 2 to 3; but so far is life from having been improved, that in all cases except where the proportions are the same, they appear to be less in favour of life than they were in the year 1777 *. Besides which, in a conversation with Mr Morgan, I find that a little inadvertency has occurred in calculating these proportions, so as to render them less in favour of life than what they seem to be. This, I have no doubt, Mr Morgan will explain, though I do not feel authorised to enter upon it. But to ascertain the accuracy of his conclusion upon the numbers taken in 1810, he made a further calculation upon 151,754 persons, members of the Equitable for 20 years, ending in the year 1821, and specifying the diseases by which the deaths were respectively occasioned; and his conclusion most decidedly is—as given to me in correspondence, and printed in my Observations upon your Report, p. 99, which I solicit permission to lay upon the table, as well from his opinions delivered in his charge to the Equitable in 1825, and personally repeated to me on Saturday last,—that life among the members of the Equitable has rather diminished than increased in value; which opinion I find also confirmed by other actuaries." "With respect to the mortality of females, he (Mr Morgan) is fully convinced that no such difference exists as to authorise any variation of tables. If such a difference had existed, he must have discovered it, because the Equitable insures both sexes very largely, and more especially upon survivorships, principally between husband and wife, consequently the excess must have appeared in the superior number of females, and this the more distinctly, as the survivor possesses the option of receiving either a gross sum, or of becoming an annuitant." Mr Becher then gives a very long and minute detail of the rates of various life assurance associations and Friendly Societies; also, a further account of the data possessed by Dr Price for the construction of his tables; but our limits preclude us quoting any more of his evidence, which occupies nearly eight pages folio, all chiefly in defence of the Northampton Tables.—*Report*, pp. 15-22.

Joshua Milne, Esq. actuary, states, that there now exist three tables, which, he conceives, show, with sufficient accuracy, the rate of general mortality, or the proportion of the people, including all ages, which die annually. Speaking with reference to this country, these three tables are "the Carlisle and two others constructed from the experience of the Equitable Society, of the mortality that has been observed to take place among its members for a period of upwards of 30 years. One of these tables was constructed by Mr Babbage, a gentleman well known and justly appreciated in the scientific world; the other by Mr Griffith Davies, actuary to the Guardian Insurance Company; they were both published in the beginning of the last year. I had, previously, in the Supplement to the Encyclopædia Britannica, given a comparison of the mortality prevailing in the several intervals of age, from 10 years to the age of 80, according to the Carlisle and Northampton Tables, and the experience of the Equitable Society; by which that experience and the Carlisle table appear to agree remarkably well. The two gentlemen just named, have since shown it at each separate age; and I have here tables of the values of annuities calculated from these three tables of mortality, compared with the results of the Northampton table, derived in a similar way. I beg leave to state, as to the nature and uses of a table of mortality, the object being to show how many persons at any one age will arrive at any greater age; the simplest way of considering it, is to suppose them all born at once. I can illustrate this subject by comparing it with the table of mortality for Sweden,

* If we rightly understand the note by Mr Morgan, at p. 182, 183 of vol. i. of Dr Price's work (7th edition), the deaths expected to occur previous to 1777, had been calculated by the table of mortality constructed by Messrs Simpson and Dods from the London Observations, while the number of deaths expected to happen during the 30 years ending with 1800, had been calculated by the Northampton table. Now, as the London table represents a much higher rate of mortality than the one for Northampton, and as the deaths among the members of the Equitable previous to 1777 bore the same proportion to the former table as the deaths occurring for the 30 years ending with 1810 did to the latter table, it necessarily follows that the duration of life must have increased since the year 1777.

which was published in my work on Annuities in the year 1815. Of 10,210 male children born in Sweden, just 6098 arrived at 15 years of age, 3026 at 60, and so on. In a male population, where the law of mortality was the same, and the number of the annual births, as well as that of the annual deaths, was constantly 10,210, the whole number of the people would be 354,733. This is where there is no migration, and, consequently, the number of persons is reduced by the law of mortality only: but if you suppose the population to increase, which has been the case for the last century and more, in almost all the countries of Europe; then of course there will be a great many in the early parts of life for whom there are no corresponding survivors in the later periods. If, for instance, the population has doubled in England within the last 45 years, then the number now existing at 15 years of age will be twice as great as it was 45 years ago; but the number at 60 will be only the survivors of those who were 15 years of age 45 years since, and consequently only half as many as the survivors 45 years hence will be, out of the persons now 15 years of age, and therefore, such a table is of no kind of use for determining the probabilities of life, and if applied to that purpose will only mislead: for instance, out of this number 6098, 45 years ago, at 15, if the population had doubled, the same table would represent only 3026 to have attained 60, whereas the 12,196, now 15, will leave twice as many survivors at 60, that is 6052; therefore, if you wish to provide annuities for them, and calculate according to that table of an increasing population, you will only provide half the annuities wanted. The principle applies in all cases, and hence it is manifest, that these tables (the Northampton) are quite unfit to determine the probabilities of life by." Mr Milne having been requested to state which table he would prefer for the calculations of Friendly Societies, declined giving any direct opinion. "Having myself constructed the Carlisle table, and calculated tables of the values of annuities from it, I would rather that the Committee should decide on that question than take my opinion; and I consider it would not be difficult to afford honourable gentlemen the means of judging with facility of the preference."—*Pages* 25, 26.

April 9.—*Francis Baily*, Esq, actuary, thinks that the safest tables for calculating annuities for the working classes would be the Swedish. According to him, out of 1000 born, there would be alive at the age of 65, "in Northampton 140, in Sweden 235, and in Carlisle 302; those have been formed from particular towns, Sweden has been made from the country at large. Friendly Societies are partly made up of persons from the country, a great portion may be in town, and a great number in the country farms." He cannot account for the extraordinary difference between the longevity of the people of Northampton and Carlisle:—hardly thinks it worth while to perplex the subject with a different rate of payment for males and for females, to ensure the same object:—has an opinion, but can hardly tell upon what it is founded—whether from the small-pox being removed, or from habits of cleanliness being more common among the lower classes—that the duration of life has increased within the last 40 years.—*Page* 27.

May 4.—*Charles Babbage* and *Benjamin Gompertz*, Esquires, actuaries.—For calculating the necessary payments by the working classes in youth and manhood for annuities in old age, Mr Babbage would prefer, of the tables he is acquainted with, the Swedish tables in Dr Price's work, or the French tables of M. Duvillard. By these tables fewer persons die from the age of 5 to 17, but after that age more than by the Swedish tables.—*Mr Gompertz* thinks the table constructed by Mr Finlaison for the Committee in 1825, agrees nearly with the Carlisle tables, and therefore, that it would be a good table to calculate endowments for children from, in consequence of its making death among the younger branches of mankind less than some of the other tables, and therefore, that a greater endowment might be expected than was calculated on; but does not think it would be by any means safe to rely on the Northampton tables for those purposes. "It appears to me, that a great part of the profit of the Equitable Assurance Company has arisen from insuring lives, in consequence of the Northampton table being more favourable to death than it

should be; and if that should be the cause of profit, of course a reverse will take place in annuities." "The society use the Northampton table, but the real experience of the Equitable appears to agree with the Carlisle tables tolerably well to a great extent; and the same observations have been made by other gentlemen—I believe Mr Babbage, Mr Davies, and Mr Milne, as well as myself."—*Mr Babbage* again remarks, that "this will afford an opportunity of explaining something which might perhaps otherwise be misunderstood. If I am asked which tables I should wish to use in making my calculations relative to the poorer orders of society, I should state that my object would be to get such tables as exactly and perfectly represented those classes throughout all their ages; but it may be said that this is unsafe, and that others should be taken where the deaths are more numerous than those which really happen. My view in all cases is, let us get as nearly as we can the law of mortality of the class for which we want to calculate, and add to the prices computed from it some proportional part sufficient to insure the safety of the establishment which uses them. I strongly object to using tables giving a greater mortality than is expected to take place, a course which has sometimes been defended on the ground of safety to the establishment. Safety is much more certainly secured by judging as nearly as possible the true risk, and adding an additional sum for security. If tables not representing the mortality of the class for whom they are designed are employed, every step in the reasonings which are deduced from them is liable to increased error; and if the calculations are at all complicated, the errors so introduced may not improbably act on the opposite side to that which they were introduced to favour." —"I will mention a little work, which is probably known to some of the members of the Committee; its title is "Annuaire;" it is published by the French Board of Longitude, and contains an account of the progress of population in France and in Paris; an account of the marriages and of births, male and female. There are some singular facts very recently established, by a large enumeration. It is published every year at the price of one franc, and contains a great deal of very useful information. It has usually been supposed, that the proportion of males born to that of females, was 21 to 20; that is to say, the quantity of males above females was one-twentieth. In France it has been observed, that out of 6,705,778 persons born, legitimate and illegitimate, there are 3,458,965 males and 3,246,813 females, or nearly 16 males to every 15 females. Out of 460,391 illegitimate children there are 235,951 males and 224,440 females. These numbers differ considerably from the ratio of 16 to 15 found among legitimate children. That ratio would give 221,204 females for 235,951 males, whereas 3,236 more females are really produced. From these data it follows, that, in France, for every 100,000 legitimate female children, there will be 106,534 legitimate males; but that for every 100,000 illegitimate female children, there will be born only 105,128 illegitimate males, so that the probability of a child's about to be born being a female is greater if it is illegitimate than if it is legitimate." In conclusion, Mr Babbage states, that he should "certainly think it would be very desirable to calculate for the poorer classes on other tables than those used for the higher classes."—*Pages* 28–33.

John Naylor, Esq. actuary of the Economic Life Assurance Society, has no hesitation in saying, that a society founded for the purpose of granting annuities, which adopted the Northampton table, and a mean rate of interest, would be ruined, from that table representing the rate of mortality by far too high. He considers Mr Finlaison's table (p. 86.) to be accurate from its near agreement with the Carlisle tables, and recommends these for the purpose of calculating annuities. He is farther decidedly of opinion, that the average duration of life has increased within the last forty years; and in farther explanation of all these points, he afterwards gave in a detailed written statement to the Committee, containing much valuable information. We can only, however, give the following extracts:—"The Northampton table is less to be depended on than any of those above mentioned, because it is not derived from proper data; no enumeration of the population, classed according to the ages, having been, in this instance, obtained. It is well known, that a table of mortality, deduced from mortuary registers only, cannot be correct, unless the population had been stationary, and the births and deaths equal,

not only during the time the registers were kept, but also during the previous century. The celebrated Dr Price supposes a table of mortality may be accurately constructed from bills of mortality, where the deaths exceed the births, if the numbers and ages of the annual settlers can be determined; and in constructing the Northampton table, he computes the number of settlers from the excess of deaths, and their ages from the bills of mortality. But the number so computed would be correct only, if the population of Northampton had remained stationary during a century and a half; and the ages could not be ascertained by the bills, unless the law of mortality (the very object of the investigation) were previously known. Little dependence can be placed on a table thus constructed. Indeed, it must be obvious, that a table of mortality, *i. e.* a table exhibiting the proportions of deaths to the numbers living at all ages, can be accurately constructed only, by means of enumerations of the living and registers of deaths, each classed according to the ages." "It is much to be lamented, in a country like England, where calculations on life contingencies are so constantly required, that no efficient means have been adopted for computing an accurate table of mortality. If frequent enumerations of the living at all ages, and registers of deaths at all ages, throughout the kingdom, were obtained, not only the law of mortality for England in general, but the variations of that law for different places, and for the same places, at different times, and the law for [illegible] ch sex, might be accurately determined." *Pages* 34–84 and 85.

May 11.—*Griffith Davies*, Esq. Actuary to the Guardian Assurance Company, states his opinion to be, that the Northampton table gives the average duration of life rather lower, and the Carlisle and Finlaison's tables somewhat higher, than that which obtains among the aggregate mass of mankind in England and Wales; and therefore that neither are well adapted for calculating payments for annuities to the members of Friendly Societies. Neither does he think the experience of the Equitable would give an accurate result for the persons insuring in Friendly Societies, a the Equitable insurers are, generally speaking, in a higher rank of life, and are more select lives than those of Friendly Societies. "On that account, unless the incidental expences necessarily attendant upon the management of societies were taken into account, the experience of the Equitable would be full high; but taking into account the uncertainty as to the rate of interest, and also the incidental expences, I think it would be more safe to use the Carlisle table, Mr Finlaison's table, or the experience of the Equitable, to determine the contributions for deferred annuities." He conceives that, throughout all ages, the duration of life is higher now than it was a hundred years ago, and that it has been gradually increasing during that period, but more particularly since the beginning of the present century. "All observations tend to confirm that female life, I believe at all ages, is better than male, and even married better than single;" and "as another corroborative of the increased value of life within the last 100 years, I think on examination of different tables, the fruitfulness of women, say from

—, prior [illegible]

adequate to compensate for the existing mortality; so that he strenuously argued that the population was decreasing in this country; and I believe that, supposing the documents he had to reason upon to be correct, the conclusion he drew was not so erroneous as it has been represented. It is not an increase in the number of births, as compared with the number of bearing women, that has increased the population, but the increased number of children that have been reared from the birth, and passed through the different stages of life." *Pages* 36–38.

Dr A. B. Granville not being aware that he should be again examined before the Committee, had not prepared the additional information which he might have done, in addition to what he had laid before the Committee in 1825. He stated, however, that he had been for some time preparing a series of tables, and a paper for the Royal Society, which would bear upon the question before the Committee. He also stated, that he had observed a very decided decrease of mortality among children from one to adult age, within

the last ten years; at least among the total number of children that came before him as patients. The Doctor likewise gave some farther results of his observations since 1825, which confirmed what he had then stated; and "with regard to the question as to the number of children that such married women may produce in a given period, I have to observe for the present, that it is a curious fact, that if a woman marries at the age of twenty-one or twenty-two, and is placed under precisely similar circumstances for the following fifteen years as women at fourteen, fifteen, and sixteen, marrying at that age, may be supposed to be under, will produce the same number of children as the latter would, though the party marry seven or eight years later; and the reason of that is this, that the latter ones, those that marry very young, cease either sooner, or go a great number of years without children. When they arrive at twenty or twenty-five years of age, they will stop till about thirty, and begin again; whereas the age of maturity at which a woman is most prolific, appears to be about twenty, and there seems no stoppage, except disease steps in, going on regularly every two years, or if she does not suckle, every year until she arrives at forty or forty-two years of age, which is the usual period for it to terminate." The whole of Dr Granville's evidence is extremely interesting; but as it is not immediately connected with our present object, we cannot afford room for a fuller detail. (*Pages* 40, 44.)

May 25.—*William Morgan*, Esq. actuary to the Equitable Assurance Office, affirms that the Northampton tables are "certainly the most correct tables for the mean duration of life, in all private concerns. For the last fifty years I have never used any other, and I think they are the most correct; indeed I know they are"—"in all cases between one man and another." It having been stated in evidence before the last Committee on Friendly Societies, that the expectation of life is now to what it was a century ago as four to three, Mr Morgan was asked if he adhered to that opinion; to which he answered that he does not adhere to it, from his own experience, "because the probabilities of life in the office, compared with those in the Northampton tables, are not higher than they were fifty years ago; indeed the very contrary."—"The duration of life, in general, is a little better among females than among males, but, in my opinion, not sufficient to render it necessary to compute separate tables for them." He thinks the Northampton Tables are as correct tables as any that can be formed, adapted to all parts and all classes of people in England, but thinks they want some little addition to secure them both for payments on death, and for deferred annuities. He is sure the tables constructed by Mr Davies, from the experience of the Equitable, were not founded on data sufficient for constructing any tables; as they hardly insure any lives under 30; and as those tables begin in early life, a great deal must be assumed where there is no data to go upon; besides, he finds the "probability of life approaching nearer to the Northampton tables in our office, than it used to be in the later periods of life; for the Northampton tables give the decrements of life as high as most tables in old age." *Pages* 45, 49.

John Pensam, Esq. actuary to the Amicable Assurance Society, states that they use the Northampton tables, but that the Society does not grant deferred annuities. Upon a comparison of the Northampton tables with the experience of the Amicable, he found the continuance of life was materially higher than that in the tables, but which he attributes to the recency of selection, or the benefit of selection rather at different ages. "I should think, in looking to annuities, the longer continuance of life would make it necessary to take some consideration exceeding the value of annuities by the Northampton tables." *Page* 50.

June 7.—*John Finlaison*, Esq. has greatly extended his observations since he was before the Committee of 1825; has gone over, of new, the whole of the calculations from which he had deduced the law of mortality, by a far more elaborate process than he had resorted to before, and the result of the whole has been, that the law of mortality, as originally stated by him in the tables before reported, is, in every part, and in every particular, upon each sex, now satisfactorily confirmed. He alludes to the table resulting from the observations on the government life annuitants (p. 80.), and attaches no particular importance to the table derived from an observation on the pensioners of Chelsea,

and Greenwich Hospitals, because it was given on a view of human life in its worst state. He therefore considers the table resulting from the government annuitants to represent most accurately the duration of life among the persons generally composing Friendly Societies. He is aware, however, that the poorer classes might be expected to die somewhat faster than those of the higher orders; but it is to be remembered, that in all Benefit Societies the members are selected lives, as well as the people who purchase annuities. If, then, the severity of labour, and the want of comforts, should subject the poor to a greater mortality, I do not believe that the difference can be very considerable, when it is borne in mind that we are here referring to picked and chosen persons from among the lower orders." *Pages* 50, 54.

June 12.—*John Finlaison*, Esq. again examined. He states, that the tables he is calculating for Government may be divided into two parts,—the one relating to the investigation of the law of mortality, and the other relating to tables, for practical use, to be deduced therefrom. "In regard to the first branch of the subject, I have completed all the materials necessary; and I am now directed, by the Lords Commissioners of the Treasury, to prepare a Report, showing the deductions which I have made, and the evidence upon which they are founded, in order that such Report may be printed by their Lordships' authority, and submitted to the investigation of scientific persons. I hope that that Report will be ready before the 1st of January next. In regard to the other branch of the subject, which relates to the practical tables, to be deduced from the law of mortality, it is of vast extent. I have now, however, the assistance of six calculators, who are at work upon it, and a very great proportion of the most necessary tables has already been calculated; perhaps nearly eight times as much as any preceding calculator has ever produced, is already executed."—"The Treasury have not, however, directed me to prepare, for present publication, any part of the work, except what relates to the law of mortality, and such tables of the values of annuities on single lives, as may be sufficient to illustrate its practical effects. The rest of the work, when finished, is intended for official purposes at the National Debt Office, and may or not be printed, according as I shall receive their Lordships' directions." He hopes that his tables "will supersede all the tables now in use; and with good reason, for they have been eight years in preparation, with all the means for perfecting them which the Government could supply, and to which no private individual has hitherto had access."—"The difference between the sexes, in regard to mortality, leads to a most important conclusion, as respects the practical purposes of societies for granting pensions to survivors. By my tables, it may, generally speaking, be said to result as follows: Supposing a mother were to leave a pension to her son, the value of such a pension would only be two-thirds of a pension left by a father to his daughter, the relative ages of the children and parents being precisely the same. It follows, therefore, that any society making no distinction of sex, and granting pensions to widows, according to the strict arithmetical result, would inevitably be ruined."

The above summary of the evidence has extended to a greater length than was at first anticipated, or may appear well adapted for the pages of a Philosophical Journal; but such a detail has been deemed necessary, in order that the interesting and important information communicated by so many intelligent and highly respectable witnesses might be duly appreciated. It would have been also very desirable to have inserted some of the tabular views of the different rates of mortality, and other illustrative documents, contained in the Appendixes, perhaps the most valuable portions of these Reports; but as we have already exceeded our limits, all that can be given additional at present, is the following table, exhibiting the expectation of life at every age above 20, deduced from tables of mortality which have been founded upon observations made in this country.

TABLE of EXPECTATION of LIFE, at and after the Age of 20 Years, according to the Northampton and Carlisle Tables of Mortality; as also, according to the Table (p. 76), deduced by* Mr John Lyon, *for the Highland Society of Scotland, from a medium of the Northampton, Carlisle, and Swedish Tables,—according to that constructed by* Mr Griffith Davies, *from the experience of the Equitable Society of London,—and according to the rate of Male and Female Mortality found by* Mr John Finlaison *to have prevailed among the Government Annuitants for the last 45 years.

The Expectation or Mean Duration of life is the number of years which a body of people, taking them one with another, may be considered as sure of enjoying,—those who live or survive beyond that period enjoying as much more time, in proportion to their number, as those who fall short of it enjoy less,—or the portion of future existence which an individual at any age may reasonably expect to enjoy. This "expectation of life" is found by dividing the total years by the number alive at the age whose expectation is required, deducting half unity or .50 from the quotient, on account of the chance being equal, whether a person shall die in the beginning or end of the year. Thus, in the Table of Mortality, (p. 76), 34,895 is the sum of the second column, at and after 25 years of age, and 965 the number living at that age, therefore, 34,895 being divided by 965, the quotient will be 36.16, and the half of 1, or .50, being subtracted from this latter number, it will leave 35.66, which is the expectation of life, according to the Highland Society's Table of Mortality, of a person aged 25.

The Probability of Life, or the chance of a person living from one age to another, is found by dividing the number living at the latter age by the number living at the former age, according to any table of mortality which may be adopted.

Hence the Value of an Annuity, commencing at any given age, or a Sum payable at Death, obviously depends upon the number of years which, according to such expectation and probability, a person of any age has to live.

Age.	Northampton.	Carlisle.	Highland Society.	Equitable Society	Government Annuitants, according to Mr Finlaison.		
					Male	Female.	Mean.
20	33.43	41.46		41.06	38.39	43.99	41.19
21	32.90	40.75	38.16	40.33	37.83	43.36	40.60
22	32.39	40.01	37.54	39.60	37.34	42.73	40.04
23	31.88	39.31	36.91	38.88	36.87	42.09	39.48
24	31.36	38.59	36.29	38.16	36.39	41.45	38.92
25	30.85	37.86	35.66	37.44	35.90	40.81	38.36
26	30.33	37.14	35.02	36.73	35.41	40.17	37.79
27	29.82	36.41	34.39	36.02	34.86	39.52	37.19
28	29.30	35.69	33.75	35.33	34.31	38.87	36.59
29	28.79	35.00	33.11	34.65	33.75	38.22	35.99
30	28.27	34.34	32.47	33.98	33.17	37.57	35.37
31	27.76	33.68	31.93	33.30	32.59	36.91	34.75
32	27.24	33.03	31.17	32.64	32.00	36.26	34.13
33	26.72	32.36	30.56	31.98	31.40	35.61	33.51
34	26.20	31.68	29.82	31.32	30.79	34.96	32.88
35	25.68	31.00	29.31	30.66	30.17	34.31	32.24
36	25.16	30.32	28.68	30.01	29.54	33.68	31.61
37	24.64	29.64	28.05	29.35	28.91	33.04	30.98
38	24.12	28.96	27.42	28.70	28.28	32.40	30.24
39	23.60	28.28	26.78	28.05	27.65	31.76	29.71
40	23.08	27.61	26.17	27.40	27.02	31.12	29.07
41	22.56	26.97	25.56	26.74	26.39	30.46	28.43
42	22.04	26.34	24.94	26.07	25.74	29.81	27.78
43	21.54	25.71	24.32	25.40	25.08	29.14	27.11
44	21.03	25.09	23.70	24.75	24.42	28.48	26.45
45	20.52	24.46	23.08	24.10	23.75	27.81	25.78
46	20.02	23.82	22.48	23.44	23.07	27.13	25.10
47	19.51	23.17	21.87	22.78	22.38	26.44	24.41
48	19.00	22.50	21.27	22.12	21.68	25.75	23.72
49	18.49	21.81	20.65	21.47	20.98	25.06	23.02
50	17.09	21.11	20.04	20.83	20.30	24.35	22.33

TABLE—continued.

Age.	Northampton.	Carlisle.	Highland Society.	Equitable Society.	Government Annuitants, according to Mr Finlaison		
					Male.	Female.	Mean.
51	17.50	20.39	19.42	20.20	19.62	23 65	21.64
52	17.02	19.68	18 82	19.59	18 97	22.93	20.95
53	16.54	18 97	18.22	19.00	18 34	22.22	20.28
54	16.06	18.28	17.62	18.43	17.73	21 50	19.62
55	15.58	17.58	17.01	17 85	17.15	20 79	18.97
56	15.10	16.89	16.43	17.28	16.57	20 08	18 33
57	14 63	16.21	15 84	16.71	16 02	19 38	17 70
58	14.15	15.55	15.25	16.15	15 47	18.69	17.08
59	13.68	14.92	14.65	15.60	14.9[illegible]	18.00	16.47
60	13.21	14.31	14.07	15.06	14.39	17 32	15.86
61	12.75	13.82	13.49	14 51	13.84	16 64	15.24
62	12 28	13.31	12 99	13.96	13.28	15.96	14.62
63	11.81	12.81	12 33	13.42	12 72	15.30	14.01
64	11.35	12.30	11.76	12 88	12.17	14.64	13.41
65	10.88	11.79	11 21	12.36	11 63	14.00	12.82
66	10.42	11.27	10.68	11.83	11.10	13 37	12.24
67	9.96	10.75	10.17	11.32	10.61	12.76	11.69
68	9.50	10.23	9.69	10.82	10.14	12.16	11.15
69	9.05	9.70	9 24	10.32	9.67	11.57	10.62
70	8.60	9.18	8.81	9.84	9 22	10.99	10.11
71	8.17	8.65	8.40	9 36	8 79	10.44	9.62
72	7.74	8.16	8 01	8 [illegible]	8 37	9.92	9.15
73	7.33	7.72	7.63	8.12	7.96	9.41	8.69
74	6.92	7.33	7.21	7.97	7.51	8.92	8.23
75	6.54	7.01	6.87	7.52	7.12	8 46	7.79
76	6.18	6.69	6 50	7.08	6.69	8 00	7.35
77	5.83	6.40	6.16	6 64	6.23	7.58	6.91
78	5.48	6.12	5 82	6.20	5.78	7.19	6.49
79	5.11	5.80	5.1[illegible]	5.78	5.35	6.83	6.09
80	4.75	5.51	5 14	5.38	4.94	6.50	5.72
81	4.41	5.21	4.81	5.00	4.55	6.20	5.38
82	4.09	4.93	4.49	4.63	4.18	5.89	5.04
83	3.80	4.65	4.18	4 30	3.82	5.57	4.70
84	3.58	4.39	3.77	4.09	3.46	5.22	4.34
85	3 37	4.12	3 62	3 73	3.12	4.84	3.98
86	3.19	3.90	3 32	3.50	2.81	4.44	3.63
87	3.01	3 71	3 04	3 31	2.53	4.03	3 28
88	2.86	3.59	2 80	3.11	2.31	3 62	2.97
89	2.66	3.47	2 50	2.91	2.12	3.21	2.67
90	2.41	3 28	2 21	2.65	1.95	2.83	2.39
91	2.09	3.26	1.92	2.36	1.83	2.49	2.16
92	1.75	3.37	1.62	2.03	1.65	2.21	1.93
93	1.37	3.48	1 30	1.70	1.49	1.97	1.73
94	1.05	3 53	0.83	1 31	1.31	1.75	1.55
95	0.75	3.53	0.50	1.05	1.18	1.55	1.37
96	0.50	3.46	0.00	.75	0.97	1 32	1.15
97		3.28		.50	0.75	1.12	0.94
98		3.07			0 50	0.94	0.72
99		2.77			0.00	0.75	
100		2.28			0 00	0.50	
101		1.79					
102		1.30					
103		0.83					

From the imperfect account which has now been given of the various investigations into the probable duration of human life, some idea may be formed of the difficulty and importance of obtaining accurate tables of mortality. The Northampton tables were the result of many years' arduous research and observations, and were consequently long considered as representing the rate of mortality in this country more accurately than any others. Whether those tables may still be the most correct for the population at large, it were needless for our present purpose to inquire; but it is obvious, from the long experience of the Equitable Society of London, and of that of the Government annuitants,—from the concurring testimony of Messrs Milne, Naylor, Gompertz, Davies, Babbage, and Finlaison, all men of the highest eminence,—and from the opinions of several other persons well informed in these matters, that the Northampton tables are unfit for the practical purposes of Health and Life Assurance. Messrs Morgan and Becher, no doubt, have endeavoured to support these tables, and have certainly urged all that can be stated in their defence; but, as is remarked in the Committee's last Report, there "is not, in truth, even a *prima facie* case made out in their favour. It is admitted that those tables were originally formed in a degree upon hypothetical data; the observations upon which they were founded come down no farther than the year 1780, or at the latest to 1791; and it is not affirmed that they have been verified by any actual and subsequent observations, or by the experience of any society which has endured for a period sufficiently long to bring to sure test the accuracy of its calculations;"—and to the evidence of Mr Milne and Mr Naylor the Committee more particularly refer for the objections to the Northampton tables, (pages 80, 82 of this Journal.)

In illustration of their effects, it is stated, that, according to the tables, out of 1000 persons existing at the age of 25, 343 will survive at the age of 65; while, by the Carlisle tables, which appear to approach very near to the truth for the higher classes, no fewer than 513 will survive that age. Hence a society which should adopt the Northampton tables for annuities, would inevitably go ultimately to ruin, for it would in all probability have three annuitants where it calculated only upon two; and of the 343

persons who would be annuitants, 98 would live for 15 years according to these tables, while 162 persons would survive through that period, and attain the age of 80 years, according to the Carlisle tables.

There is also given in the Report a comparison of the results of various tables of mortality, constructed from observations made in Britain, in France, and in Sweden; but we shall only select those of this country.

	By Dr Pike's Table, founded on the Register of Births and Burials at Northampton.	By Mr Milne's Table, founded on the Mortality observed at Carlisle.	By Mr Griffith Davies's Table, founded on the Experience of the Equitable Life Insurance Office.	By Mr Finlaison's Tables, founded on the Experience of the Government Life Annuit. According to his First Investigation, as mentioned in his evidence in 1825. *Mean of both Sexes.*	By Mr Finlaison's Tables, founded on the Experience of the Government Life Annuit. According to his Second Investigation, as mentioned in his evidence in 1827. *Mean of both Sexes.*
Of 100,000 persons aged 25, there would be alive at the age of 65	34,286	51,335	49,330	53,470	53,950
Of 100,000 persons aged 65, there would be alive at the age of 80	28,738	31,577	37,267	38,655	37,355
	Years	Years	Years	Years	Years
Expectation of life at the age of 25	30.85	37.86	37.45	38,35	38.52
Expectation of life at the age of 65	10.88	11.79	12.35	12.81	12.50
Value of an annuity of £1 on a life aged 25, interest at 4 per cent.	£15.438	£17.645	£17.494	£17.531	£17.034
Value of an annuity of £1 on a life aged 65, interest at 4 per cent.	£7.761	£8.307	£8.635	£8.896	£8.751
Value of a deferred annuity of £1 commencing at 65, to a life now aged 25, interest at 4 per cent.	£0.55424	£0.88823	£0.88723	£0.99078	£0.98334

Note.—In the above Tables, it is to be observed, that the mortality is deduced from an equal or nearly equal number of each sex, with the single exception of Mr Davies's Table founded on the experience of the Equitable. In which office, from the practical objects of Life Insurance, it is evident the male sex must have composed the vast majority of lives subjected to mortality. But as it is agreed on all hands, that the duration of life among females exceeds that of males, it follows that the results of Mr Davies's Table fall materially short of what they would have been if the facts on which he has reasoned had comprehended an equal number of each sex.

No comparison is here given of the different values of sums payable at death; but it may be stated that a society, whose

premiums were calculated by the Northampton tables, and by interest at 4 per cent., would take from a person insuring at the age of 25, either a single sum of £367 : 15 : 5, or an annual payment during life of £22 : 7 : 5, for £1000 payable at death; while, by the Carlisle table, and assuming the rate of interest to be also 4 per cent., one single payment of £282 : 17 : 8, or an annual one of £15 : 3 . 5, would only be required.

"Upon the whole, your Committee are of opinion, that the Carlisle Tables may prudently be adopted for general purposes, including that now in view, the valuation of an allowance in old age. Mr Finlaison's, which are the most recent of all the Tables, would, in all cases, give a higher expectation of life, and consequently require a larger payment from the members of a Friendly Society; but the objection arising from *selection* does apply, in a considerable degree, to these Tables; and Mr Finlaison himself bears testimony to the sufficiency of the Carlisle Tables."—*Report*, *p.* 8.

This opinion, with the immense mass of documentary and other evidence which has been obtained in the course of the late inquiries, cannot fail to be of the utmost importance to all ranks of the community; and to the higher classes in particular, as shewing both their rate of mortality from their own experience, and also the excessive premiums which they have usually been charged for assurances at death.

While, however, the mortality of those in the better ranks of life has been found to correspond very nearly with that represented by the Carlisle tables, it is by no means clear that the same rate prevails among the members of Friendly Societies. Regarding this contingency, no results from their experience have as yet been obtained; but as sickness and accidents are undeniably increased among the working classes, by noxious and dangerous employments, by ill ventilated dwellings, scarcity of food and clothing, and by many other causes, from all of which the higher classes are in a great measure, if not altogether, free, so it necessarily follows that the mortality will be greater among the members of these Societies than among those of Life Assurance Associations. Nor can we reconcile the idea of a high rate of sickness with that of a low rate of mortality, as has been virtually done by Messrs Finlaison and Davies, in calculating their proposed rates of contributions and benefits for the members of Friendly Societies.

Taking, therefore, those circumstances into view, and more especially that not nearly the same attention will be paid by these societies in the selection of their members, as is done by Life Assurance Companies, it is evident that a somewhat higher table of mortality should be adopted for the purposes of the former than of the latter class of assurers. Security, no doubt, ought always to be a principal object of these societies; but, as is remarked by Mr Babbage, "Safety is much more certainly secured by judging as nearly as possible the true risk, and adding an additional sum for security. If tables not representing the mortality of the class for whom they are designed are employed, every step in the reasonings which are deduced from them is liable to increased error; and if the calculations are at all complicated, the errors so introduced may not improbably act on the opposite side to that which they were introduced to favour."

By referring, then, to the table of expectations of life at p. 86, it must be obvious that the rate of mortality adopted in the Report of the Highland Society of Scotland will represent pretty accurately that of the working classes, and consequently that their table is the most suitable for all the purposes of Friendly Societies.

(To be continued.)

Sketch of the Physical Geography of the Malvern Hills. By WILLIAM AINSWORTH, Esq. Member of the Royal College of Surgeons, Edinburgh, &c. (Communicated by the Author).

THE Malvern Hills form a range running nearly due north and south, through part of the three counties of Gloucester, Worcester and Hereford, and seldom attaining any great height; but their rugged outline, and bold acclivity, rising abruptly in the centre of a champaign and level country, make them remarkable, giving to the eye of the stranger the same impressions of independence of origin and formation, as their difference of structure does to the judgment of the geognost. They have not unaptly been compared to the Sierra of the Spaniards,

From their peculiarity of outline, height, and pointed summits, they are fully entitled to be called mountains, though, as Lamouroux (*Cours elementaire de Geogr. Phys.*) would say, mountains of the second and third order. They are one continuous range, having no lateral branches; they have no pseudo or extinct volcanoes, or ignivomous mountains; nor do they present any mineral allied to the products of volcanic action, excepting in as far as they are composed of primitive granite (Daubeny *on Volcanoes*). Their form varies but little: the Worcestershire Beacon, and the two most southern hills, have the most acute pointed summits. The Herefordshire Beacons have been altered by the labours of the Romans, digging trenches in the talus for their encampment; while the adjoining hills, which will be found to be the oldest districts of the range, present the most rounded tops, as being formed of more easily decomposed rock. Two of the hills are cultivated to their very summits: the ground is tilled by means of three-pronged forks; and there is but a very slight difference between the abundance and date of ripening in the crops reared on the hills, and those vegetating in the valleys below. The summits are not distinctly marked out from the acclivity: there are about sixteen in the whole range; a few are isolated, but more generally they are connected, as in the hill between the Whyche and the Sedbury and Upton road, which, rising gradually from the south, forms five summits, before it reaches the highest point, where it forms an insulated prominent head, which the Norwegians, whose language is rich in names for the different forms of mountains, call *Kullen*, while a round or less prominent hill is *Nuden* (Von Buch, p. 52.). From this point it afterwards descends, forming another rival series of summits, to where the pass is hewn out of the solid rock for the Whyche road *. The rock in this case every where rises to the north, so that one of the extensive slopes lies in the direction of the dip of the mountain rock, another in a direction contrary to

* The last southern summit of this range, descending towards the Herefordshire Beacon, makes a curve round to the west, forming a table land, on which houses are built, and part laid out in gardens. The Herefordshire Beacon descending with a gradual slope to the east, bends slightly round in that direction; the convexity of the first corresponding with the concavity of the

that dip, and on that side the summits are more abrupt, and the acclivities less clothed with vegetation. The highest hills of the range, viz. the North Hill and the Worcestershire and Herefordshire Beacons, have a more perpendicular slope to the north; and throughout the whole range, the angle of the acclivity is greater on the southern and eastern than on the northern and western aspects. The ridges are also much more numerous and distinctly marked on the north-east, than any where else.

There are, strictly speaking, only five valleys, and all of these run in transverse directions; nor is there a single valley to be met with running longitudinally with the mountain-range. Wherever they occur, roads are cut through them: the deepest is the one through which the road passes from Sedbury to Cheltenham. No boulder-masses or field-stones are found in these valleys; and the alluvial or transported soil seldom exceeds twenty or thirty feet in depth on the base of the hills.

No river of any magnitude takes its rise from this range. The springs are numerous: there are eight to the west, and as many if not more to the east; they have long been remarkable for their purity, but have only met with a few advocates for any peculiar medical efficacy, their chemical analysis not favouring any such views. They are so superficial, that experiments on their temperature did not afford an approximation sufficiently identical, or approaching to the mean temperature of the latitude or locality, to be worth recording. Those rising on the east run their course immediately into the Severn: those on the west, on the contrary, divide in their direction from the Herefordshire Beacon, which is thus shewn to be, though not the highest hill, yet the most elevated part of the range corresponding to its geognostical importance. Those to the south run into a stream which joins the Severn at Gloucester: those on the north join the river Cadwell, which unites with the Terne, the latter finally emptying its waters into the Severn at Leigh near Worcester.

latter, exemplifying that the same rules exist with segments of spheres, as Buffon has laid down with respect to angles, and thus the valley through which passes the Sedbury road is formed.

An examination of the geognostical structure of the Malvern Hills offers the following positions :

1st, That, throughout the whole range, the various rocks entering into the composition of the mountain-masses contain no organic remains.

2d, That in no place are they found superimposed on, or alternating with, rocks containing organic remains, or which, from mechanical analysis, are known to be formations deposited subsequent to the appearance of organization.

From the most northerly point to as far as their structure can be investigated in the south, they present an uniform series of primitive rocks, from highly crystalline granite to the more compact chlorite-slate ; and the transitions between these two rocks may, with a little patience of research, be traced throughout all their gradations ;—not that these gradations occur exactly in accordance with the relative situation of the mountain-masses, but that, in particular localities, such transitions are distinctly marked out. The central part of the range, comprising the Herefordshire Beacon and its table land, the hill extending to the north to Whyche road, and the hill above Eastnor Wood to the south of the Beacon, are all composed of granite, with slight local variations of texture. Dr MacCulloch has remarked, that specimens may frequently be obtained from beds of gneiss, undistinguishable from genuine granite, an example of which he mentions as occurring in South Uist ; and further remarks, " that the views of the geologist, embracing a wide field, must not be limited by variations which are minute, irregular, and inconsistent, and which do not affect the broader principles that regulate his investigations." However just these remarks may be, they admit of too much latitude of expression to accord with the severe science of a philosophy founded on observation alone. From the slaty appearance which these rocks sometimes present,—from the general tendency which, throughout the whole mountain range, they show towards assuming the appearance of gneiss, the more crystalline portion of the series might be considered as mere varieties of that formation. This suggestion I would, however, strongly oppose. To assign the proper denomination to a rock whose connexions and mechanical texture offer distinctive and recognizable characters, is a basis to all strict geognostical science. When, therefore, we find a rock in all its characters a representative of granite, assuming the highest situation in the range, independent in itself, and only varying through gradual transitions into subordinate formations, it becomes a genuine granite, and in situation and chemical constituents marks itself out as the oldest rock and basis of the mountain range. Its investigation *in situ* is interesting, and affords in its localities very marked distinctions. The hills which it forms, though bold and rugged in their outline, are nevertheless the most rounded at their summits of any in the range. The Herefordshire Beacon, which I have already mentioned, may be divided into two summits, each having the remains of a Roman encampment on it, as well as the neighbouring southern hill, formed of a red granite, in which flesh-coloured felspar is by far the most abundant ingredient, mica being a rare component, and often entirely wanting. The whole rock appears so liable to decomposition, that near Eastnor Wood it is quarried and sieved for gravel. It bears a great analogy to the red granite met with between Loch

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Glenshead and Inverary; but its effects in destroying vegetation on the sides of the hills are not so remarkable as in the Grampians,— a circumstance most probably owing to the diminished height, less perpendicular slope, and more genial clime of the Malvern Hills, than to any material difference in the constituents of these two rocks. It is worthy of remark, that the ridges by which the Roman encampments are still so distinctly traced, are scooped out of the granitic rock itself, and that the walls are not, as might be supposed, the gravel, and other residue of digging the furrow, but always formed of the native rock, which, to the present day, crops out in some situations hard and unchanged by the lapse of years, and must have presented a much more secure barrier than the unconnected residue of their operations, placed without support on an abrupt and oftentimes precipitous acclivity.

On the hill between the Sedbury and Upton, and the Whyche road, which rises from the two opposite points of the compass to a summit which attains an elevation of more than 1500 feet above the level of the sea, this granite becomes more compact, retaining, however, on the summit, the same characters; but on the road, where several extensive sections are to be met with, becoming much changed, and at times its constituents are almost amalgamated the one into the other, being at some points, more especially at a quarry on the Sedbury road, very nearly allied to a chlorite-slate. This quarry, towards its upper part, presents very much the appearance of distinct stratification. In fact, wherever large sections of this or the former rock occur, they may distinctly be perceived to have a dip towards the south, and involuntarily give to the mind of the geologist the idea of a once stratified rock heaved up, deranged in the parallelism of its strata and the uniformity of its direction, yet still preserving the same dip and inclination. Not fifty yards from the milestone near the last-mentioned quarry, a vein of the same compact feldspathic rock may be seen rising in an almost vertical direction, and traversing the adjacent strata almost at right angles; it is scarcely two feet broad. At the section made through the rock, affording a passage for the Whyche road, the red granite may also be perceived occupying apparently distinct localities, presenting the appearance of beds in the more compact and frequently ironshot mountain-rock. The mica at this point becomes more abundant, and soon forms the principal constituent. The red granite is frequently almost entirely feldspathic; beyond the hill crystals of hornblende first make their appearance, and becoming gradually more abundant, have led the English geognosts to consider the whole as a sienitic formation. Undoubtedly if in any part of the range such a rock occurs, a few partial beds are to be met with here, but not in sufficiently extensive formations to be considered as the basis of the range; but to this I shall have occasion to refer afterwards.

The investigation of the geognostical structure of the two most northerly hills in the Malvern range, though interesting, presents little variety. Known by the names of the Worcestershire Beacon and the North Hill, they lie nearly due north and south of one another, the latter being the more northerly, and intersected by a narrow valley, deeper and more abrupt on the eastern side. No stratification is discernible excepting on the western aspect, where a gentle dip to the north may be perceived, and a direction of its strata

apparently east and west. On the eastern side, the new red conglomerate * makes its appearance, covering the sides of the Worcestershire Beacon. The occurrence of this formation implies either a breaking and elevation of its strata, by causes similar to those to which perhaps the Malvern Hills owe their existence, or the deposition of the sandstone subsequent to the hills, a supposition implying a stratification of the last-mentioned rock nearly parallel to the acclivity of the hill, or in a more or less concave form filling up its base, neither of which last mentioned appearances are presented by this rock; and, in the second place, implying an elevation of the formation, which, according to Werner, in common with all flœtz rocks, is at once chemically and mechanically deposited, little supported by the confined limits of the formation.

To the north-west low hills of limestone are found running nearly parallel with the portion of the range which they face. The rock interposed between them and the granite is old red sandstone, and in their organic remains and texture they bear too remarkable an analogy with the hills of the same formation which crop out, bounding at intervals the red marl across the whole of England, not to be referred to the same formation which at Calcford is associated with the old red sandstone, and with greywacke at Chepstow and Monmouth.

The mechanical analysis of the rocks forming these two hills, indicates that both are mountain-masses of granite, presenting, however, great variety of texture, and appearances, with difficulty associated by the geognost. The granite is generally speaking close-grained, containing both mica and hornblende, the latter, however, often entirely wanting; highly crystalline granite, with little mica and no hornblende, becoming as much a part of the mountain-mass as that formation. It occurs principally *en filons*, which is particularly remarkable at the pass through which the Whyche road is cut. If, with Jameson, we consider strata as similar contiguous masses, and beds as dissimilar, these *filons* will come under the latter denomination, and so we may avoid exciting prejudices by adverting to the stratification of granitic rocks. In these beds felspar is the most abundant constituent,—not, however, occurring in prisms, disseminated through a quartzose basis, but rather itself forming a basis for imperfectly crystallized quartz, with now and then partial scales of mica. On the Worcestershire Beacon, a vein of quartz, of a few feet in breadth, occurs traversing the rock in a nearly vertical direction. On the southern part of the hill, a hole has been dug, with a view of obtaining for strangers visiting these hills specimens of mica, which, from their highly metalline lustre, have been called gold †. This is a bed traversing the granite

* This formation, the variegated sandstone *(Bunter sandstein)* of Werner, has not unaptly been called by the English geologists Red Marl, as, whenever I have applied acids, the application has been accompanied with effervescence. Though, as its name imports, its general colour is red, yet it almost everywhere, where large sections are presented to the eye, exhibits streaks of a more compact sandstone, of a light blue or cream colour.

† The decomposition of granite first commences from a chemical change taking place in the iron, which, in however small quantities, is yet universally distributed through the mineral kingdom. The water and extraneous moisture gaining access to it, converts it to a state of hydrate and peroxide, increasing its bulk, and thus destroying its amalgamating effect on the rock, and, at the

in a direction nearly at right angles. Wherever I could examine it, it was so weathered as to render my decisions very fallacious. It has, however, to all appearances a decomposed basis of felspar (clay-slate) with folia of mica, towards the surface; and, when exposed to decomposing agents, possessing a high metalline lustre, becoming towards the centre of the rock, dark and shining. If the formation was sufficiently extensive, it would be called a porphyry. I have only met with an account of a similar rock occurring near Felsobanya in Transylvania, and in Saxony. With respect to the accuracy of denominating these formations Sienite, I need only remark, that, notwithstanding it has been proved that the rock from which a supposed similar series has received its name from the time of Pliny, is not a compound of hornblende, quartz and felspar, as first advanced by Werner, and that this name becomes no longer applicable to the same set *, still, under all circumstances, this rock has no claim to that title: the dissemination of hornblende is not universal, though in some places abundant, yet it is regulated by particular localities. The existence of mica, in some places so abundant, is at once decisive as to its real characters; and though hornblende is met with as a mineral occurring often in abundance, but yet not so universally as to be entitled to be called a mineral constituent, or to give to the formation a name depending on its occurrence.

Under these circumstances, Worcestershire Beacon and North Hill, like Hereford Beacon, will be formed of granite, containing occasionally crystals of hornblende, and associated with gneiss, which, with little variation, forms the northern part of the Beacon, and the whole of the North Hill. I did not perceive it any where alternating with the granite.

To the north, then, the central granite varies slightly in its appearance, becoming slaty-granular, yet scarcely ever losing its distinctive characters. Towards the south, however, it presents more remarkable differences, and becomes scarcely recognisable in the more compact and less crystalline rocks forming the southern outline of the mountain-range. On the hill to the south of Hereford Beacon, a cave has been artificially hewn out of a portion of the mountain rock, which juts out beyond the regular acclivity, barren, and covered only with a few stunted lichens. In this cave, though not many feet deep, the *Hypnum splendens* and *lutescens*, and a *Bryum*, put forth their leaves to a vegetation never exceeding five or six lines in length, and then wither. This portion of the rock is more compact than the body of the hill, and proves that the nature of the mountain must not be judged of by the examination of a portion which, by the opposition its structure offers to decomposing agents, is barren, and unclothed with vegetation, offering,

same time, by the increase in size thus given to its particles, disseminated so generally through the mass, uniting chemically and mechanically to destroy the cohesion, and influence the further decomposition of the rock itself. In a close-grained granite, the felspar becomes of a redder hue, and is gradually reduced to an impalpable powder, or from the quantity of alumina entering into its composition, forms a basis of slate-clay: the pieces of quartz change gradually their form, and generally roll off in the shape of pebbles; while the lamellæ of mica, the last to be decomposed, often exhibit a metalline lustre.

* M. de Humboldt has proposed the name of *Sinaite.*

at the same time, great facilities to the geognost; for, as in this case, they will generally be found to vary a little in their structure,—circumstances which, of themselves, account for their solitary bleakness, when compared with the other side, and oftentimes the adjacent portion of the hill. The first transition is, when the quartz becoming less extensive, and the mica more abundant, at the same time assumes gradually a more lamellar aspect, and becomes a distinct gneiss. This transition may be observed on the hill forming the third summit to the south of Hereford Beacon. Its next transitions are two-fold, on the one hand losing almost all parallelism of lamellæ, the mica less distinct, and becoming more or less amalgamated with the other constituents, forming a blue chlorite-slate, at times very much resembling the same formation as it occurs on the north of Tarbet Bay, in the Mull of Cantyre, and known to Faujas St Fond and other old geologists by the name of *Lapis ollaris*. It is this rock, which some authors, mentioning the occurrence of greenstone in these hills, have, I suppose, mistaken for it.

On the other hand, the mica becomes still more prevalent in the rock, the slaty structure more decidedly marked, and in all its characters it approximates to mica-slate. This may be most distinctly seen in the London road that crosses the southern extremity of the hills. De Saussure has very expressively called gneiss *Granite veiné*. The term conveys the ground of distinction between gneiss and mica-slate; yet the distinctive characters of this rock are not sufficiently well marked out to warrant its receiving the latter appellation. To the west, it again becomes very compact, and less crystalline, the mica becomes almost entirely lost, and the rock becomes a dark quartzose mass. Finally, this last hill is divided by the deep valley through which courses the London road from a mountain-mass of gneiss and chlorite-slate, whose compact structure, and power of resisting decomposition, have given to the last-mentioned hills more acute summits than any others in the range. The transition of the gneiss into green chlorite-slate, I did not actually trace *in situ*; but, by fracturing some of the larger pieces rolled down the sides of the hills, or even examining the broken stones on the road, many examples will be found, fully demonstrating that it is a mere transition of the first-mentioned rock into a more compact and less distinctly lamellar mass. Beyond this, cultivation has effaced the bold outline and rugged grandeur of the primitive mountains, and the line between the old rocks and the superincumbent formations becomes totally lost.

From these investigations, the following general facts may be deduced:

1. That the Malvern Hills are composed of that class of rocks denominated primitive, including granite, gneiss, and chlorite-slate.
2. That these rocks are indefinitely stratified, having generally a direction from east to west, and rising with little variation to the north.
3. That they contain no organic remains, nor are ever found alternating with or superimposed on rocks of a more modern formation, and that they are of a formation much more ancient than the surrounding rocks; and though theoretically, it is not impossible that they might have assumed their present situation at a period more modern than the deposition of the old red sandstone, or even of the red marl, that they nevertheless

are neither chemically or mechanically connected with those formations, but of a much older date.

4. That as they are older, so they assume a more lofty situation than the surrounding more modern formations, even than the oolite capping the summits of the Cotteswold range, or the transition limestone of Bristol and Calesford.

5. and *lastly*, That, in their nature, situation, and appearance, they bear evidence with the granitic hills of Cumberland, North Wales, Anglesea, Cornwall, and more especially Mount Sorrel in Leicestershire, that the intricate and numerously alternating modern formations of England, lie upon rocks of granite *.

In their mechanical analysis, the Malvern Hills afford

A highly crystalline compound of flesh-coloured felspar and quartz.

Of felspar, quartz and mica.

Of felspar, quartz, and hornblende.

Of felspar, quartz, hornblende, and mica.

Of felspar and mica.

These are all referrible to the class Granite, varying in the predominance and proportion of the ingredients. In the next transition, the rock becomes more compact in its texture; and the folia of mica ranging themselves in laminæ, give a veined appearance to the formation. This is genuine gneiss, distinguishable, as found on the Malvern Hills, into

1*st*, Gneiss, in which felspar and quartz are the most abundant ingredients.

2*d*, In which felspar and mica alternate in layers.

3*d*, In which mica becomes the predominant ingredient, verging into mica-slate.

The compounds of felspar and mica exist, 1*st*, In a highly crystalline state. 2*d*, In a state in which the felspar becoming decomposed, offers a clay-slate basis to crystals or foliæ of mica. 3*d*, In which the felspar is almost entirely lost, and the mica assumes a metallic lustre and appearance.

The gneiss varies from its veined structure into a compact granular green rock, whose principal ingredient is generally quartz, at first slightly lamellar, and soon becoming small-grained lamellar, and more indistinctly crystallized (chlorite-slate).

The geographical distribution of Plants on the Malvern Hills does not offer any very remarkable features. Their height does not allow of the growth in a single latitude of plants of a whole zone; and the temperature at the summits of the hills differs too little from that of the valley, to afford much difference in the nature of its vegetation. The plants of the genus *Erica* are rare for apparently so favourable a situation. Bushes of the *Spartium scoparium* are to be met with above Little Malvern, and to the south of the hills. Specimens of *Genista Anglica*, *Ononis arvensis*, *Ulex europæus* and *nanus*, are scattered about the hills; but excepting the Grasses, the Ferns are by far the most abundant plants filling the valleys, while the dwarf fern gives a green covering to the

* According to these views, the formation south of London, more especially the chalk traced by Mr Conybeare as far as Prussia, would still come under this clause, as in Great Britain they lie on their north-western boundary on granite; and on their eastern, their relation is finally every the same.

rocks above. I did not meet with the *Viola lutea.* I visited the hills in September: at the time of flowering it is likely it might be found; the *V. tricolor* was flowering in abundance. To offer a list of the plants growing on the hills themselves, or at their base, is needless, as it would embrace half the compendium of British plants. I shall allude only to the rarer ones. The most remarkable, and those which seem to have claimed these hills as their own, are the *Digitalis purpurea*, of which a white variety is often met with, and the *Hyoscyamus niger*, most abundant on the North Hill, and above Eastnor Wood a variety occurs with five racemes: whenever the soil has been accidentally disturbed, it sends forth its leaves, and, like the *Digitalis*, abounds most in those stony spots which the *Motacilla œnanthe* has marked out as his abode. In the moist places towards the base of the range, *Marchantia polymorpha, Serapias longifolia, Orchis bifolia, O. conopsea, O. ustulata, Ranunculus lingua, Myosotis minimus, R. parviflorus, Colchicum autumnale, Polygonum minus, P. aviculare, P. viviparum, Scirpus acicularis, Satyrium viride, Campanula rotundifolia, patula, latifolia,* &c. In the woods, *Galanthus nivalis, Chlora perfoliata, Aquilegia vulgaris, Acer campestris* and *pseudo-platanus*, &c. &c. The brambles and briars are covered with the *Clematis* and *Tamus communis.* On the hills, *Arenaria tenuifolia, Drosera rotundifolia, Fumaria claviculata, Cistus helianthemum, C. polyfolius, Helleborus viridis, Hypericum androsæmum,* &c. On the granite rocks, were found the *Sedum album*, and *Cotyledon umbilicus.* On the limestone rocks the *Potentilla verna* flowers prettily; and the following list of the Lichens which I obtained, is a pretty accurate list of those which are to be found on this range: *Lichen geographicus, L. islandicus, L. parellus, L. physodes L. plicatus, L. pustulatus, L. rangiferinus, L. scrobiculus,* and *L. scrobiculatus.*

1. *Proposed Improvement in the Theory of Sound, and in the mode of Measuring its Velocity.* 2. *On the Theory of the Variation of the Barometer.* By H. MEIKLE, Esq. Communicated by the Author.

THE propagation of sound through elastic fluids, was first considered by Sir Isaac Newton; but his investigations led to a result considerably short of 1142 feet, the experimental velocity in a second, so long received in this country, and which, owing to some inaccuracy, was far above the truth; for the mean velocity is now found by experiment to be only about 1100 feet. Newton's result still lay much below the latter number; but those who have investigated the velocity from the same data, have acquiesced in his conclusion. It was not known in Newton's days, that, when air undergoes a change of volume, it at same time changes its capacity for heat, becoming warmer by compression,

and colder by rarefaction. The want of acquaintance with this circumstance, has led him and many others into the erroneous conclusion, that the particles of elastic fluids repel each other with forces inversely as their central distances, which could never be the case, if the capacity be affected, no matter in what manner or degree, by a change of density. Newton himself has shewn in his *Principia*, that, if the cube of the pressure in an elastic fluid were as the fourth power of the density, the particles must repel each other with forces inversely as the *squares* of their central distances. Now, the experiments of the French philosophers nearly agree with such a relation subsisting between the pressure and density of air. Numerous experiments which I have made on this subject, answer almost exactly, and this was far from my expectation; for, till these experiments were made, I had conjectured that the true result would lie quite on the contrary side of those obtained in France; but on perceiving that my result accorded with the existence of a repulsion between the particles of air inversely as the *squares* of their distances, which is such a general law of nature, I was led to adopt this as the true law of gaseous repulsion. MM. Desormes and Clement have given a particular description of their apparatus and mode of experimenting, in the 89th volume of the *Journal de Physique*. But I am not aware that any intelligible account has been published of the apparatus employed by MM. Gay-Lussac and Welter; though, from the brief and obscure hints given in the 12th book of the *Mecanique Céléste*, I still suspect they are liable to some of the inaccuracies which I hinted at in the Number of this Journal for April last, and used every means to avoid, in my own experiments.

The late celebrated Marquis Laplace had often directed his attention to this subject; and reflecting that sound is propagated by aërial undulations, which cause a compression of the air as they move along, he conjectured that such compression, by generating an increase of temperature, augmented the elasticity of the air, and consequently the velocity of sound; and that this was the reason why Newton's result fell short of experiment. According to Laplace, the velocity of sound, as deduced by Newton's theory, and which is about 916.3 feet, should be multiplied by the square root of the quotient obtained by dividing

the specific heat of air under a constant pressure, by its specific heat under a constant volume, viz. 1.1547. Still, however, this multiplier, as obtained from the experiments above mentioned on the specific heat of air, gives the velocity of sound too small. The object of the present article is to suggest a reason for this deficiency.

The theory of sound, as improved by Laplace, supposes it to be propagated by a wave of air, having an increased temperature, without any addition to its quantity of heat; but as each portion of the air forming the wave is warm when it communicates motion to the next, it must also impart to it a portion of its heat *. Hence, sound is propagated by a wave of air, having not merely its temperature increased by compression, but having also an addition to its quantity of heat. In this way, a wave of heat accompanies sound through the air; and I presume, that to it we owe the excess of the experimental, over the theoretical, velocity of Laplace. The theory of this distinguished philosopher lays no stress on the *amount* of the rise of temperature; but such amount must depend on the degree of compression, that is, on the *intensity* of sound; and as the transference of a quantity of heat from each portion to the next, will be greater as its excess of temperature is greater, it is clear that the velocity of sound must be greater when it is more intense. I am perfectly aware, that some suppose sounds of all intensities to be propagated with the same velocity, and allege as a proof, the undisturbed succession of musical notes, when heard at a distance. So far as regards the present inquiry, I need only remark, that musical notes, or the differences of their intensities, are mere playthings, when compared with the penetrating report of a cannon issuing from the flames.

From the account of experiments made in Holland by Dr Moll, with many excellent precautions, and published in the *Philosophical Transactions* for 1824, p. 424, it appears that sound moved slower from Kooltjesberg to Zevenboompjes, than in the

* Heat cannot be here lost laterally, because sound is propagated, not in an insulated line of air, but rather as in a pyramidal figure, or something like a spherical sector, having the sonorous body for its centre, as is plain from sounds being heard over a considerable lateral extent. A line of air, therefore, which is not near the outside of the sector, will lose no heat laterally.

opposite direction. For, on the 25th June, p. 452, the interval is longer, even when sound could not be heard in the opposite direction, than the mean of both directions on the 27th and 28th June *. This difference, I apprehend, has arisen from the difference of the guns, or of the mode of charging and firing them.

When the production of sound is accompanied with intense heat, as in the firing of guns, there is reason to think that a portion of such heat is propagated from one portion of air to another along with the sound. On this account, I conceive that the report of a gun moves faster than the sound of a bell, over and above what is due to superior intensity. As, however, a bell is not heard at such a distance as a gun, and the methods hitherto employed are too complicated for measuring with accuracy or facility the minute interval of time in which a sound passes over a small distance, the exact velocity of sound from bells has not yet been determined. I therefore beg to propose the following simple expedient, by which I presume the difficulty of measuring the minute interval of time would be entirely obviated. I shall begin with a very familiar illustration of the principle.

Suppose a hammer, moved by clock-work, to strike a bell at equal short intervals, as seconds, and that an observer sees the hammer just touch the bell, at the very instant when he first hears the sound. It is evident, that he must be either quite near the bell, or at such a distance as requires exactly one second, or a whole number of seconds, for the sound to reach him †. By removing himself a very little farther off, the sound will arrive too late, and by approaching rather nearer, the report will precede the visible stroke. In short, a very small variation on the distance will sensibly disturb the coincidence; and

* In pages 430, 431, some experiments are mentioned as made in *January* 1823, which, from the rest of the article, seems so exceedingly improbable, that I think the author or translator, not being alike familiar with both languages, has put *January* several times for *June*.

† I here mention *seconds* for convenience; but in practice, I suspect the intervals must be at least of sufficient length to keep the sounds of the strokes quite distinct; which, at any rate, will require very small intervals. If the vibrations caused by music were quite clear of each other, the velocities of the notes might not be so nearly equal.

as this experiment might be often repeated in the course of a few minutes, ample opportunity would be afforded for determining the exact distance which should make the two sensations perfectly harmonize.

But instead of watching the motions of the hammer itself, a more precise and conspicuous signal might easily be contrived; such as a long index, completing a revolution during each interval between the strokes, and then passing or covering some conspicuous mark or line. For experiments in the dark, a small hole might be opened, and instantly shut by the clock-work, at the very nick of time to allow a lamp placed behind a screen sending a momentary ray to the observer.

This brief outline, I hope, will make it evident, that such machines, in proper hands, would tend in a great measure to obviate the uncertainty inseparable from hurriedly measuring the short interval of time which elapses during the motion of the sound of bells over small distances. For, if the visible signal be observed exactly to agree with the sound, we are sure of the true elapsed time, from the rate of the clock, without flustering ourselves to measure it at the moment. The observer, in this mode of operating, would merely be required to walk a very little backward and forward till he found himself at the exact distance. But, as neither eyes nor ears are in all persons equally acute, several observers might be employed at each station; and if they did not exactly agree about the distance, this might lead to a more minute investigation of the circumstances.

For the better obviating the effects of wind, a clock would be required at each end of the base over which the sound was to pass. They need only be pieces of strong machinery, without any compensation to the pendulums; and yet from them the minute interval of time could be obtained, to a degree of exactness to which the nicest chronometer, when used as formerly, can have no pretensions: For the method now proposed possesses the same sort of advantages over the former method, that Hadley's quadrant does in measuring angles at sea over the old instruments.

The theory of sound is besides very imperfect, otherwise it would not leave us so much in the dark regarding the sovereign

controul which wind exercises over the *intensity* of sound, and which is the more remarkable, considering the vast disproportion of their velocities. It is generally supposed that the relative velocity of sound and wind is not affected by the motion of the latter; but this opinion stands much in need of confirmation. It is clear, that the effect of wind on sound is very different from merely bearing it along, as a current in the ocean does a floating body. For in this way, the intensity would undergo no sensible change; whereas, we know, that, in most cases, wind annihilates sound, when opposed to it, and magnifies it prodigiously when moving in the same direction. The most natural inference which we can draw from this is, that wind reflects sound in the opposite direction; something in the way that the tide sends the *bore* up a river.

The tremendous explosion of the Stobbs Powder Mills in 1824, shewed, in a very striking light, how feebly, and to how short a distance, sound moves against the wind, while it is prodigiously strengthened to leeward. A moderate breeze then blew from the south-west, and, although in the opposite direction, the report was loud, and the houses sensibly shaken, to the distance of thirty miles, yet very few heard it, and that feebly, three miles to windward.

Chap. III. Book xii. of the *Mécanique Céleste*, is devoted to the theory of sound, and forms a continuation of the author's speculations on heat and gases contained in the two preceding chapters. In it, particularly pages 127, 128, occur some of the formulæ that are employed in the memoir of M. Poisson on the same subject; and which are closely allied to what I commenced with in the Number of this Journal for October 1826. I then pointed out an error into which these eminent mathematicians had fallen, in determining the proper form of the integral of a differential equation; and which error arose from their introducing a needless and erroneous hypothesis, at variance with the conditions of the problem. The mistake to which I allude admits of being placed in a still clearer point of view; and this becomes the more necessary, considering the very unfair representation which Mr Ivory has given of what, in the *Phil. Mag.* for April last, he calls the equations of the *Mécanique Céleste*; though, in fact, the equations which he has produced there, to-

gether with the errors he complains of, are the offspring of his own contradictory hypotheses, and do not proceed from the real nature of the subject. This will be rendered evident from the perfect consistency of the following plain view of the case, in which no hypothetical work is introduced.

Let t be the temperature, or rather the indication on the common scale of an air thermometer, p the corresponding pressure, and ϱ the density of a mass of air; then a being the expansion for one degree, and b another constant, we have, from the law of Boyle,

$$p = b\varrho\,(1 + at) \ldots\ldots (\text{A.})$$

Whilst the quantity of heat in any body undergoes the minute variation dq, the corresponding variation dt in its temperature must obviously be inversely as its specific heat. Hence,

$$dt : 1^\circ :: dq : \frac{dq}{dt} \times 1^\circ,$$

the last term of which is the general expression for the specific heat of any body; especially if the volume and pressure do not vary at the same time, for in that case, the variation of heat might not change the temperature. But differentiating equation (A) with p constant, we obtain

$$dt = -\frac{1 + at}{a\varrho} \cdot d\varrho,$$

and substituting this value of dt in the general expression, the specific heat of air under a constant pressure, relatively to a degree of the scale to which t belongs, is

$$-\frac{dq}{d\varrho} \cdot \frac{a\varrho}{1 + at} \times 1^\circ.$$

Differentiating, again, equation (A) with ϱ constant, and supposing that the mass of air undergoes the same variation dq in its quantity of heat as in the former case, we obtain for the specific heat of air under a constant volume, for the same degree of the thermometer,

$$\frac{dq}{dp} \cdot \frac{ap}{1 + at} \times 1^\circ.$$

Now, it is admitted by all parties, and corresponds with experiment, that these specific heats have to each other an invariable ratio; or, in other words, that the relations of the differentials is of a known and determinate character. Hence, they are of the fittest possible sort for integration. Calling this constant ratio that of $k : 1$, and we get

$$k \cdot \frac{dq}{dp} \cdot \frac{ap}{1 + at} \times 1^\circ + \frac{dq}{d\varrho} \cdot \frac{a\varrho}{1 + at} \times 1^\circ = 0.$$

From the conditions under which we have obtained this equation, dq has the same value in both terms. The degree of the common scale, considered as a linear quantity, is constant, and is likewise the same in both terms. Hence, dividing by the common factors, we obtain

$$\frac{dp}{p} = -k\frac{d\varrho}{\varrho},$$

an extremely simple equation, the integration of which is free from all ambiguity, and gives $p = \varrho^k$; supposing p and ϱ to become each equal to unit at the same instant *. It hence follows, that the general expression for q, or for any change which occurs in the quantity of heat contained in the air, is no "*arbitrary* function," such as we might modify at our whim or fancy, but a *determinate* function, fixed down by the above condition; that the pressure vary as the k power of the density, in every case whatever, in which the quantity of heat in the mass of air undergoes no change, or when $q = 0$; and this condition will accord with no other form but what I formerly gave, viz.

$$q = B (\log p - k \log \varrho) + C.$$

It is very remarkable, that four of the greatest mathematicians of the age should have been so completely bewildered regarding this integration. *1st*, The Marquis Laplace, *Mec. Cel.* tome v. p. 127.; *2d*, M. Poisson. *Annales de Chim.* xxiii. 338.; *3d*, Mr Herapath, *Phil. Mag.* lxii. 329. †; and Mr Ivory even after the only possible form of the function had been clearly pointed out, as I have shewn at length in the Number of this Journal for July last.

2. *On the Theory of the Variations of the Barometer.*

In the *Supplement* to the *Encyclopædia Britannica*, Professor Leslie has proposed a theory of the depressions of the barometer, in which he supposes, that the wind describing a curve in passing over the surface of the globe, acquires a centrifugal force sufficient to diminish the pressure of the air on the earth's surface, and consequently to depress the barometer.* Mr Daniell, in his *Meteorological Essays*, has endeavoured to controvert this theory; but I am not sure that I have caught the meaning of either of these gentlemen in their respective arguments, and therefore do not pretend to decide on their merits.

If we proceed to compute the centrifugal force of air, as if consisting of detached particles like sand, revolving in circles about the earth's centre, the result is by no means considerable; but, to

* This supposition has nothing to do with the value of the results: it merely gives the formula a neater appearance.

† It is but justice to M. Poisson to observe, that Mr Herapath, in his first note, page 328, accuses him of setting out with the hypothesis, that the increments of expansion, under a constant pressure, are proportional to the increments of heat; whereas nothing of the kind is assumed, till he had got to p. 330, after having obtained the "*arbitrary* function," as they are pleased to call it.

admit the correctness of such a conclusion, would be taking for granted, that the fluidity and the mutual action of the particles on each other do not affect the result. Mr Tredgold has lately shewn, that Newton's overlooking this circumstance, in investigating the laws of the resistance of fluids, has led him and his followers into very erroneous conclusions; and, by hastily pursuing a similar path, we should have reason to fear the like consequences. It was probably considerations of this nature which induced Mr Leslie not to apply the ordinary mode of estimating the centrifugal force of solids to the fluid atmosphere.

There is, however, a very important circumstance connected with the centrifugal force of wind, which does not appear to have been yet attended to, and which throws a very different light on the subject, though still adding greatly to the probability that the barometer has to do with the centrifugal force. The circumstance to which I allude is, that the curvilinear motion of wind, describing a circle about the earth, in place of always *lowering* the barometer, ought frequently to *augment* the pressure of the atmosphere, and consequently to *raise* the barometer. At first sight, this may seem paradoxical enough, if not thoroughly absurd; but to solve it, we have only to consider, that, when the wind is from the east, its diurnal motion round the earth's axis is thereby lessened, its centrifugal force will be of course weakened; and so the air will be more at liberty to gravitate or press freely on the earth's surface, and consequently to *raise* the barometer. Westerly winds, on the contrary, by conspiring with the diurnal motion, increase the centrifugal force, and diminish the pressure. Hence the reason why the barometer is commonly lower with westerly winds than easterly. Such difference of effects in opposite winds, so far as centrifugal force is concerned, will become smaller as the latitude increases, and the currents approach nearer to the direction of the meridian. But cold air from a higher latitude raises the barometer, from its being heavier than the comparatively moist and warmer air of a lower latitude. Hence, from the combination of these two causes, the barometer in this country is usually highest with a north-east, and lowest with a south-west wind.

But the effects just mentioned are liable to be modified or overruled, by various causes of a less general nature. The de-

scent of the barometer during storms, I conceive to be frequently influenced in no small degree by the reaction of the wind on the acclivities of the earth's surface. When a horizontally moving wind encounters an inclined plane, its direction is thereby more or less elevated, and an increase of pressure necessarily takes place on the reflecting surface. The whole pressure on the inclined plane, when estimated in the vertical direction, is obviously reduced in the ratio of the cosine of the inclination to radius; but still the vertical force exerted within a horizontal square inch will, from the principles of hydrodynamics, be the same as the pressure on an inch of the inclined surface. If the one be equal to a column of 35 or 40 inches of mercury, so will the other. This vertical pressure, therefore, exceeds that of the barometer, in a sheltered place on the same level, in the same ratio as the direct force on the inclined plane does. Even a wall or precipice opposed to the wind, will occasion a greater pressure on the ground at the windward side of its base. Hence the mean of the whole vertical pressures over an extensive district, exceeds what is indicated by the barometer in a sheltered spot.

Since, then, these surfaces, on which the wind forcibly acts, sustain a weight greater in proportion to the part of the horizon which they occupy, than the rest of the district does, a part of the weight of the atmosphere is, as it were, supported on pillars during a storm; but the pressure indicated by our barometers in sheltered spots, being only the diminished pressure between the pillars, is therefore too small. This affords one very satisfactory reason why the barometer should so often be depressed during storms, especially where the surface of the country is uneven, and sometimes likewise in a ship riding among mountain-like waves.

Between the tropics, the wind usually blows from the east, diminishing the centrifugal force, which so far accounts for its not depressing the barometer. And if, as is believed, the aërial currents from the south-east and north-east, by meeting near the equator, unite in a current directly from the east, which has no other mode of escape but by accumulating upwards, and flowing back to the tropics, this will afford a farther explanation. For the greater the wind, the more will it tend to accumulate

the air about the equator. So that the depression of the barometer, due to the action of the wind on the acclivities of the surface, seems to be prevented in the vicinity of the equator, by the weight of a greater mass of air. But this, after all, is attended with some difficulties.

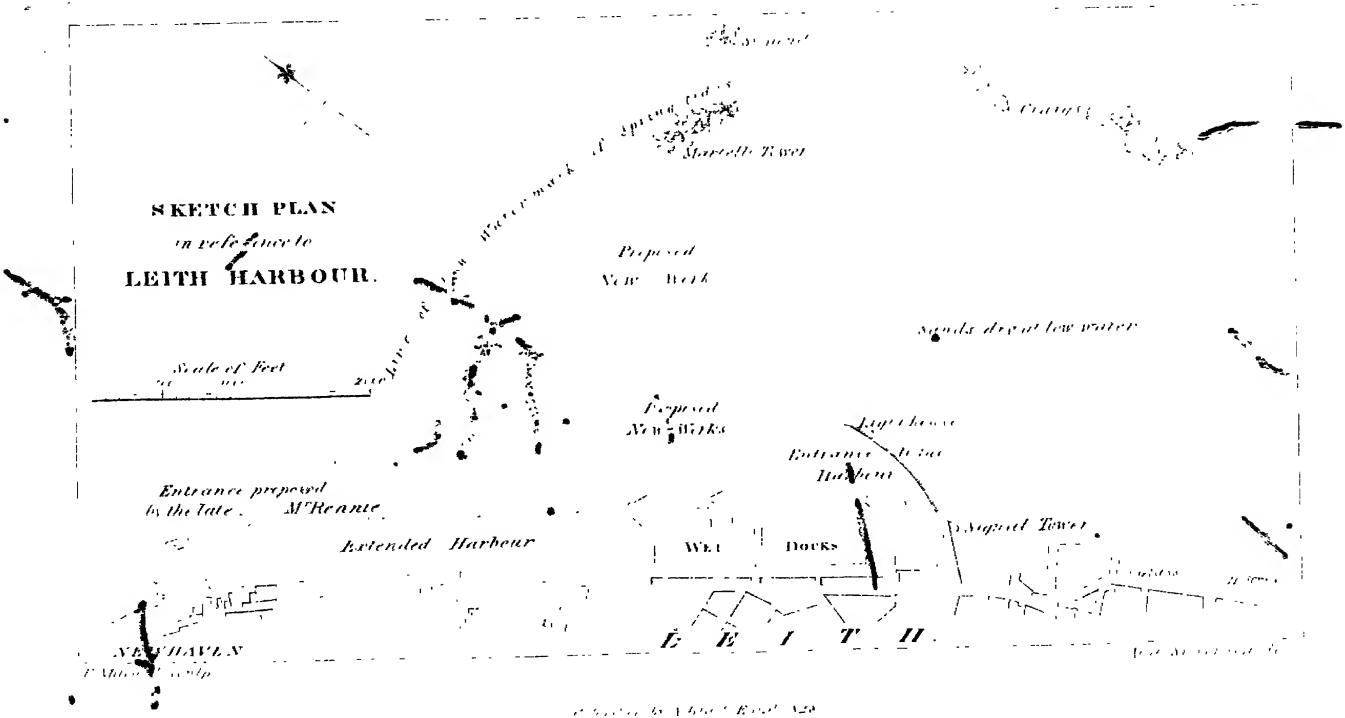
Excerpt from a Memoir on British Harbours, drawn up in the year 1824. By R. Stevenson, Esq. F.R.S.E. & M.W.S. &c. Civil Engineer. With a Plan. (Communicated by the Author *.)

Leith Roads.—OUR nautical readers know that the Frith of Forth is a principal rendezvous for shipping during the storms which affect the eastern coast of Great Britain; and as a naval station, especially in the event of war with any of the northern powers, it is of primary importance to the best interests of the nation. To those who are not locally acquainted with this great estuary, we may notice, that its access is obvious, and its navigation easy. Leith Roads, which afford its chief anchorage, are ample and commodious, possessing a soft bottom, with a depth of water varying from three to upwards of seven fathoms, and, for larger vessels, to sixteen and eighteen fathoms. Connected with this extensive roadstead there are other valuable mooring grounds above Queensferry, which resemble the higher parts of Plymouth Sound and Portsmouth, in regard to the shelter and security which they afford to shipping.

Leith Harbour.—Leith Harbour, the subject of the present section, is situate on the southern side of the Roads above described, at the embouchure of the river Leith, about two miles north from Edinburgh, of which it is the port. The advancement of this harbour is consequently an important object with the corporation of that capital, and also with the constituted

* Mr Stevenson communicated to us his Memoir on British Harbours nearly three years ago; but from the state of the Leith Harbour Bill, then before Parliament, and other considerations of delicacy, the author requested us to delay its publication. There being now a variety of opinions regarding this object of great commercial importance, we have obtained Mr Stevenson's consent to the publication of an excerpt of the Memoir.—Edit.

PLATE 3


SKETCH PLAN
in reference to
LEITH HARBOUR.
Scale of Feet
Martello Tower
Proposed
New Work
Sands dry at low water
Proposed
New Works
Entrance to the
Harbour
Entrance proposed
by the late
M'Reanie
Extended Harbour
Wet
Docks
Signal Tower
NEWHAVEN
L E I T H

authorities of the town of Leith. I am now, therefore, to give some account of it, and to state what appears to me most suitable for its improvement.

At high-water of ordinary neap-tides there is a depth of only about eight or nine feet at the present entrance of Leith Harbour, and in spring-tides the depth is about thirteen or fourteen feet. From the peculiar form of its piers, and, particularly, owing to a considerable extension of the eastern pier beyond the western one, as will be seen from the accompanying sketch-plan, vessels are by this means often shut up for a length of time with north-westerly winds. Till of late years the birthage of the harbour was confined to the bed of the river, and had become so extremely incommodious from the increase of shipping, that its enlargement became indispensable. An additional revenue was accordingly provided; and two spacious wet-docks, extending to ten acres, were formed. These docks have proved a vast accommodation to the port; but a great desideratum still remains, in the want of a sufficient depth of water, and a more commodious entrance for the reception of large ships.

If we inquire into the cause of the shallowness of the water at Leith, and generally along the southern shores of this frith, it may be accounted for, on the great scale, by the set both of the flood and ebb tides, in the following manner. The strongest current, for example, of the flood-tide, in its course from the Atlantic Ocean, runs along the coasts of Caithness, Aberdeen, and Kincardine, to the higher parts of the Frith of Forth, meeting with comparatively few obstructions on the northern side; whereas the stream of tide which supplies its southern shores, separates off St Abb's Head, in Berwickshire,—one branch of the tide proceeding to the English coast, and the other along the Lothians up the Frith. This last, however, has more the character of an eddy-tide, having changed its course almost at right angles, at or near St Abb's Head, and being further intersected in its progress by the Bass and other islands lying off the coast of Haddingtonshire. At Gullen Ness, which forms one of the chops of the inner part of the Frith, the channel suddenly expands into the comparatively great bay of Musselburgh. This expanse gives another check to the velocity of the tide, which at Leith is again obstructed by a chain of rocks extending toward Inchkeith, throwing the currents, both of flood and ebb, still off the

southern shore. Between Leith and the Narrows at Queensferry, the incumbrance is continued by the interposition of Cramond Island and the foul grounds of Mickery and Oxscares, which altogether are favourable to the process of deposition on this shore; while the force of the current and consequent depth of water are increased upon the northern side. Of this we have an anomalous example at Queensferry, where the soundings are about thirty-five fathoms in depth, and consequently greater than on the same parallel of latitude any where between the Frith of Forth and the opposite coast of Denmark.

The great obstacle to the improvement of the present entrance of Leith harbour arises from the extensive flat or bank trending northward to the rocky grounds called the Symonds, lying seaward of the Martello Tower, as delineated on the annexed Sketch of the shore between Leith and Newhaven, shewing the figure of the bank and the position of the respective rocks in the offing. On the southern side of the Frith, immediately above Newhaven, the scouring effect of the tide is chiefly with the ebb, and thus we account for the peculiar form of the sand-bank off Leith, and the greater depth of water off Newhaven: at this place the bank is comparatively narrow, and it attains its greatest breadth off the entrance to Leith Harbour.

The scouring effects of the river Leith are, no doubt, beneficial to its alveus: but if we carefully examine this matter, we shall find, from the extent and flatness of the ground, that its influence is, upon the whole, languid. The bar does not consist of mud, but of sand, similar to that which is deposited above and below Leith It is not a particular ridge, but an extensive flat, which has its origin in the local set of the tides, arising from the configuration of the shores opposed to the tidal current. I am therefore of opinion, that every effort to deepen the present entrance of the harbour, which stops short of carrying two continuous piers at a very moderate distance from each other, seaward of the Symond Rocks, or to the extent of about a mile from the shore at Leith, will not only prove ineffectual, but that one pier, of any form, which extends much beyond the other, will prove ruinous to the best interests of the port. I would not, however, be understood as recommending so extensive a plan of operations, as the extension of piers to the Symond Rocks,

but merely as stating what humbly appears to be the only practicable mode of deepening the present entrance to the harbour of Leith.

In quest of this object, some have projected the extension of a single pier, in various lines of direction, toward the Martello Tower, as a weir to the current. Others, with somewhat more plausibility, carry two piers to a certain extent over the sand-bank, and then proceed with one pier to the Martello Tower, as shown in dotted lines upon the Plan. I confess that I have never been able to satisfy myself upon this point, either as to its beneficial effect upon the bar, or its proper influence upon the accessibility of the harbour. To illustrate this, we simply refer to the present state of things. For example, every one conversant with the nautical localities of Leith knows the difficulty experienced in leaving the port with north-westerly or favourable winds down the frith. In such cases, a vessel must *cast off*, or make sail, from the western pier, beyond which the eastern one projects about 100 yards. But let us imagine that this single pier were extended to a mile, or even 1000 yards, and then, according to our views of seamanship, the difficulties attending the access of the harbour would be increased tenfold; or, as before noticed, "it would prove ruinous to the best interests of the port."

To obviate this state of things, it has been proposed to project a pier from Newhaven, till it meets the continuation of an eastern pier beyond the Symond Rocks, or seaward of the Martello Tower. By this means, several hundred acres of sand-bank, which dries at low-water, would be included in the form of a great outer harbour. In this case, it appears to be impossible to avoid the silting up of so large a space as would thereby be included by the two piers projecting respectively from Leith and Newhaven, while the effect of the winds, at high-water, upon a surface of about one mile in breadth, would render it extremely difficult to transport vessels through it, to or from the interior harbour. It is therefore to be feared, that, after having expended a very large sum in either of these diversified operations, we should only have an incommodious, if not impracticable, harbour.

Having made these observations on the set of the tides, and the natural situation of Leith harbour, in allusion to various

plans latterly suggested for its improvement, we shall now endeavour to inquire into the effect and tendency of executing in whole, or in part, the apparently abandoned plan of the late eminent Mr Rennie, and upon which, it is believed, upwards of £200,000 have already been expended. When Mr Rennie was consulted on this subject, about the year 1800, he had before him an early design by Mr Whitworth, a celebrated engineer of his day, who had proposed to extend the birthage of the harbour, by following the course of the river above Leith Saw-mills. But when Mr Rennie maturely considered this subject, and took into view the natural difficulties which present themselves, to forming a deep-water entrance to Leith harbour from which the tide ebbs to the extent of about one mile, he was properly induced to form a design suitable for vessels of a greater draught of water than were generally in use in Mr Whitworth's time, by opening a communication at Newhaven.

Now, as the greatest breadth of the sand-bank above alluded to is immediately off the present entrance to Leith harbour, and as the bank becomes narrower as we approach Newhaven, a more commodious line of direction is evidently by the erection of a continuous sea-wall toward Newhaven; where a sufficient depth of water may be obtained for His Majesty's ships of war After therefore consulting with that eminently scientific navigator, the late Captain Huddart, who made a survey of Leith, Mr Rennie ultimately determined upon placing the deep-water access to the harbour near Newhaven, as delineated in dotted lines upon the accompanying plan. I have endeavoured to give the subject of the improvement of this harbour every possible attention, and I am humbly of opinion, that no design for this purpose has yet been submitted to the public, which seems to warrant the total abandonment of Mr Rennie's plan. I am also confident that it may be satisfactorily shown, not only to be the best which, under all circumstances, can now be followed; but also, that the least expensive mode of obtaining a deep-water entrance is to continue the sea-wall from the docks westward; for I do not now propose a suite of docks from Leith to Newhaven, but merely a *tide-harbour*, which might be occasionally scoured from the present wet-docks. To take a practical example of this, let it be observed that a sea-wall from the wet-docks toward Newhaven would not be more than two-thirds of the extent of the pier required, to carry a ship to a similar depth of water

off the Martello Tower, as may be seen from the accompanying Plan.

We are aware that the proposed entrance at Newhaven is distant from the chief seat of business in Leith, and that it is difficult for those accustomed to the present state of things to look favourably upon any other view of the subject; but, in point of fact, the pier-head near Newhaven would not be more distant from the central parts of Leith than a pier at the Martello Tower, while the former would be much more commodious and accessible than the latter. In every extended port, more or less inconveniency of this description is felt; and if the situation of the merchants of Leith be contrasted with that of their brethren of London, Liverpool, Dublin, and many others, they will appear to have little cause to complain, although the entrance of the harbour were at Newhaven.

Upon the whole, I hesitate not to recommend that the entrance to Leith harbour should forthwith be improved upon a moderate scale. Its present condition is a source of much inconveniency to the trade of Leith, having, perhaps, as difficult and awkward an access as I have anywhere met with in the whole course of my survey, and personal observation, on "British Harbours" between the Shetland and Scilly Islands. I am further of opinion that a sea-wall should be extended from the wet-docks toward Newhaven, and that a deep-water entrance should there be formed, upon the principle, if not the form, suggested by Mr Rennie. This, as formerly stated, I conceive to be the most proper and convenient mode of acquiring a sufficient depth of water, and also the most economical mode of improvement of which the port of Leith is susceptible.

Observations on the Coal-field, and accompanying Strata, in the vicinity of Dalkeith, Mid-Lothian. By Robert Bald, Esq. F. R. S. E., M. W. S., &c. Mining-Engineer *. (Communicated by the Author.)

Having, in a former paper, which I read before this Society, made several observations upon the Mid-Lothian Coal-fields, I have, since that time, made many investigations of this very interesting district; and these confirm the ideas I had formed of

* Read before the Wernerian Natural History Society 7th April 1827.

the coal strata in the vicinity of Dalkeith, viz. that the edge-coals, and accompanying strata, found at the collieries of Drum and Gilmerton, four miles south of Edinburgh, with the well-known bed of limestone, which lies immediately under all the workable coals, decline into the centre of the valley, southward, to a very great depth, and then deflect, rising to the south, and are again found at Dalkeith, where the lime rock, under the lowest workable coal, is found, and wrought extensively. We therefore conclude, that the bed of lime-rock in the lower part of the Dalkeith section, is a continuation of the lime-rock at Gilmerton; that the coal named the Parrot Coal in the sections, corresponds with the lowest coal at Gilmerton, next the lime-rock, named the North Green Coal; and that the several coals above the parrot-coal in the section correspond with the edge-coals which lie above the said north green coal.

The following minute section of the strata was made in the course of running a day-level some years ago from the South Esk, to drain the Marquis of Lothian's coal-field along the Roman-camp Hill. The strata cut through had a dip of from one in four to one in three; but the section now exhibited shews the strata in a perpendicular line at the South Esk, calculated from the horizontal section; which perpendicular section extends to the depth of 387 fathoms to the lime-rock. In it are found no less than 27 beds of coal, making a total thickness of 82 feet 8 inches. The different beds of separate and distinct coals passed through are of various thickness, extending from 6 inches to 9 feet, and lie at very various distances from each other, as is common in all coal-fields.

Section of the Coals, and their accompanying Strata, beginning at the surface.

	Fath.	Ft.	In.
1. Alluvial soil	2	0	0
Slate sandstone	2	0	0
White sandstone	0	4	0
Red sandstone	2	4	0
5. Blue sandstone	1	0	0
White sandstone	0	4	0
Red sandstone	0	5	0
Slate sandstone	0	3	0
Slate clay	0	2	6
Carry forward	10	4	6
Brought forward	10	4	6
10. Coal	0	0	6
Indurated clay	1	4	0
Do. do. hard	1	0	0
Coal	0	1	6
Indurated clay	0	1	6
15. White sandstone	0	1	6
Red sandstone	5	3	0
Slate clay	0	4	0
Carry forward	20	2	6

		Fath.	Ft.	In.
	Brought forward	20	2	6
	White sandstone	0	3	0
	Slate clay	1	2	0
20.	White sandstone	0	3	0
	Slate clay, very hard	0	3	0
	Do. do. soft	0	4	6
	Coal	0	2	0
	Indurated clay	1	0	0
25.	Red sandstone	3	3	0
	Slaty sandstone	2	0	0
	White sandstone	0	3	0
	Slaty sandstone	2	1	0
	Slate clay with Coal	0	3	0
30	Slaty sandstone	2	2	0
	Red sandstone	3	3	0
	Slate clay with Coal	0	3	6
	Indurated clay	1	0	0
	Coal	0	2	9
35	Indurated clay	3	1	0
	Red sandstone	10	4	0
	Indurated clay	1	4	0
	Red sandstone	11	4	0
	Bituminous clay	0	4	0
40	Red Sandstone	4	1	0
	Indurated clay	0	4	0
	Red Sandstone	0	4	0
	Bituminous shale	0	4	0
	Red sandstone	2	0	0
45	Slate clay	1	2	0
	Red sandstone	1	0	0
	Slate clay	0	3	0
	Red sandstone	1	3	0
	Slate clay	0	5	0
50	Red sandstone	2	3	0
	Slate clay, very dark	3	0	0
	Do. lighter	1	1	0
	Indurated clay, coarse	3	3	0
	White sandstone	1	3	0
55	Slate clay, very dark	0	4	0
	Do light	2	3	0
	Do. white	1	1	0
	Red sandstone	10	1	6
	Slate clay	1	0	0
60	Grey Sandstone	3	3	0
	Slate clay	0	4	0
	Red sandstone	6	3	0
	Slate clay	0	4	8
	Carry forward	121	4	5

		Fat.	Ft.	In.
	Brought forward	121	4	5
	Indurated clay with Coal	0	3	0
65	Bituminous shale	1	0	0
	Do. very hard	1	3	0
	White sandstone	0	5	0
	Indurated clay	0	4	0
	White sandstone	0	4	0
70	Indurated clay	0	3	0
	Do. soft	0	3	0
	White sandstone	0	4	0
	Red sandstone	2	3	0
	White sandstone	1	0	6
75	Coal	0	2	6
	Indurated clay	1	4	0
	White Sandstone, hard	3	3	0
	Slaty sandstone	[illegible]	[illegible]	0
	Slate clay	2	4	6
80	Grey sandstone	1	0	0
	Slate clay	1	1	6
	Red sandstone	0	3	0
	Slate clay	8	0	0
	Grey sandstone	2	0	0
85	Coal	0	3	0
	Indurated clay	1	4	0
	Whitish sandstone	13	3	0
	Slate clay with ironstone balls	16	0	0
	White sandstone	7	0	0
90	Slate clay	0	4	0
	White sandstone	0	5	0
	Slate clay	1	3	0
	White sandstone	6	3	0
	Slate clay	1	0	0
95	White sandstone	1	2	0
	Slate clay with ironstone	6	1	6
	Bituminous shale, coarse	1	0	0
	Slate clay with ironstone	1	0	0
	Red sandstone	2	4	0
100	Coal	0	3	0
	Slate clay	2	4	0
	White sandstone	4	0	0
	Do.	2	3	0
	Do.	4	4	0
105	Slate clay	4	0	0
	White sandstone	3	0	0
	Blue sandstone	1	4	6
	Red sandstone	0	4	6
	Carry forward	148	3	5

No.	Strata	Fath.	Ft.	In.
	Brought forward	148	3	5
	Slate clay	0	2	0
110	Coal	0	2	0
	Slate clay with ironstone	2	0	0
	White sandstone	1	3	0
	Slate clay with sandstone	2	2	0
	Slate clay	0	3	0
115	Coal	0	2	3
	Indurated clay	0	2	3
	White sandstone	1	4	0
	Slate clay, hard	2	3	0
	Coal	0	3	0
120	Indurated clay	0	3	0
	Red sandstone	3	4	0
	Slate clay	1	4	0
	Coal	0	3	0
	Indurated clay	0	3	0
125	Red sandstone with a bed of slate clay	9	4	6
	Coal	1	3	0
	Indurated Clay	0	2	6
	White sandstone	0	5	0
	Slate clay	0	1	3
130	Coal	0	3	0
	White sandstone	2	3	0
	Slate clay	0	4	6
	Coal	0	2	0
	Indurated clay	0	1	6
135	Slate clay	1	1	[illegible]
	Coal	0	3	[illegible]
	Slate clay	2	1	6
	Coal	0	4	[illegible]
	Slate clay, light	2	3	[illegible]
140	Do. dark	1	1	[illegible]
	Do. light	0	2	
	Carry forward	293	3	1

No.	Strata	Fath.	Ft.	In.
	Brought forward			
	White sandstone			
	Coal			
	Slate clay	0		
45	Coal	0		
	White sandstone	3		
	Slate clay with Coal	0		
	Slate clay	2		
	Coal	0		
50	Slate clay	1		
	White sandstone	3		
	Coal	0		
	Red sandstone	4		
54	Coal	0		
	Total ascertained depth	316	2	7
	Various strata	15	1	0
A	Coal	0	3	6
	Various strata	6	0	0
B	Coal	1	0	0
	Various strata, depth not precisely ascertained; but the coals marked A, B, C, D, E, are from the best information that could be obtained,	19	0	9
C	Coal	0	5	3
	Various strata	3	2	3
D	Second Splint Coal	0	3	9
	Various strata	19	3	0
E	Parrot Coal	0	3	0
	Various strata		0	0
	Total supposed depth	387	1	1
	Then the LIMESTONE ROCK, &c.			

But great and valuable as this section shews the Mid-Lothian coal-field to be, it only comprehends the class of Edge-Coals on both sides of the coal basin with the underlying bed of lime-rock. None of the very valuable coals, termed the Flat Coals, which chiefly supply Edinburgh, are comprehended in it; for hitherto the strata betwixt the upper coals in the section and the flat-coals, which lie above these, have not been accurately ascer-

tained, but the chief of these coals are presently working at the collieries of Sheriff-hall and Edmonstone in the middle of the valley, and are well known in the Edinburgh market; particularly the two named the Diamond and the Jewel coals, which are of very superior quality.

The following is a Section of the Coals in the Edmonstone Colliery district.

	ROCKS.			COAL.	
	Fath.	Ft.	In.	Ft.	In.
Alluvial cover - -	8	0	0		
Rock strata - -	6	0	0		
Coal - -	0	5	0	5	0
Various rock strata (containing Coals)	31	0	0		
Splint Coal - -	0	5	0	5	0
Various strata - -	6	4	3		
Coal, named Coal-Rough -	0	4	6	4	6
Various strata - -	5	3	0		
Coal named Beeffy Coal -	0	3	0	3	0
Various strata - -	12	1	6		
Diamond Coal - -	0	5	0	5	0
Various strata - -	4	1	6		
Jewel Coal - -	0	5	0	5	0
	78	2	0	27	6

There is a coal said to be much mixed with pyrites, named the Gold Coal, which lies under the jewel coal, but it never has been wrought, nor the strata explored accurately under it. The strata betwixt the upper coal in the Dalkeith section and the pavement of the jewel coal have not yet been ascertained.

Of the twenty-six coals in the section only two are unworkable to profit, from their thinness being only six inches thick. The thinnest coal reckoned workable is one of 18 inches thick. Hence, if the thickness of all the workable coals ascertained in the Dalkeith district be added together, they amount to the uncommon thickness of 109 feet 6 inches; viz.

Coal in the section, - -	82	0
Flat coals ascertained, - -	27	6
Total, -	109	6

This exhibits a body of workable coal altogether uncommon, and is of the highest importance and value to the capital of Scotland for affording a supply of coal for many generations. It is, however, particularly to be remarked, that this astonishing thickness of coal is found not to extend the whole length of the basin, from the sea at Fisherrow to its western extremity at Magbie Hill and Carlops: the coals continue only to the great road leading from Edinburgh to Dalkeith at Sheriff-hall, where there is a dislocation, which throws the coal strata up to the west, and has the effect of throwing off all the valuable flat coals, as they are not to be found westward of that line; and it appears that the flat coals found at Eldin, Polton, Dalhousie, and Whitehill collieries, are part of the edge-coals rendered flat by the slip or dislocation.

This coal-field extends to the south side of the Roman-camp Hill near Dalkeith, and takes a reverse dip to the south; then deflects, and rises again to the south near the village of Ford.

I have now to make the following remarks on this coal-field and sections.

All the coals are of the common bituminous kind, partly splint and partly cubical coal.

The strata betwixt the coals are various shades of yellow, white, grey, and bluish coloured sandstone, argillaceous schistus, bituminous shale, argillaceous earth, named Fire-clay, and a little coarse clay limestone in some places. All the coals are of open burning quality:—no caking coals have ever been found.

The coals lie, in general, at the common distances from each other, as in other coal-fields, with this remarkable exception, that betwixt the coal marked No. 34. in the section, and the next coal under it, marked No. 75., the distance is no less than 90 fathoms, or 540 feet, in which space there is no coal. I know of no such thickness of strata in a coal-field without a coal being found; and it is a fact of great importance in the searching of a district for coal.

There are no beds of greenstone found in the strata hitherto explored, although there are several vertical dikes or veins of this rock, which intersect the strata seen in the Port-Seaton district along the shore.

There is very little ironstone found in the strata, less than in any other Scotch coal-field; so much so, that none has been got for the purpose of making iron in the district now treated of. Bands and balls of good ironstone have been found, and a little wrought, at the verge of the coal-field near Aberlady and Gossford, on the estate of Lord Wemyss.

Lastly, it is a remarkable fact, that no inflammable air has been found in any of the mines of this district, however deep, though found in abundance in the coal mines in the counties of Stirling, Lanark, Renfrew, and Ayr. The Lothian mines, being free from this most destructive pestilence, is a great comfort, and no common blessing to the miners. Carbonic acid gas is frequently found, but happily few misfortunes arise from it.

As the carburetted hydrogen is certainly produced from the coal, we might have expected it in the Lothian coal-field, which affords parrot or cannel coal of the best quality for producing the greatest quantity of gas, as each pound of this coal produces from 4 to 5 cubic feet of gas.

With regard to the depth of the coal strata of this coalfield, in which the beds of coal and organic remains are found, I am of opinion, that in the deepest part of the basin it will extend to at least 500 fathoms or 3000 feet, which shews how very deep the valleys have probably once been; and the more so, if the theory of the mountains having been at one period much higher than they now are, is taken into account.

In an economical point of view, relating to the quantity of coal in Great Britain, upon which the numerous manufactories and population depend for fuel,—it is frequently asked, Will not the coals in the kingdom be soon exhausted? That they are rapidly exhausting, is evident to any one of the least observation, particularly from the increased depth of the coal-pits; and it being estimated that more coal has been wrought during the last hundred years, since the general application of the steam-engine, in working the mines, and at manufactories, than was wrought and used for the 500 years preceding, when coals first began to be commonly used for domestic purposes. Nevertheless, great as the consumption is, and greatly as this has been increased during these last twenty years, still the quantity of coals remaining to be wrought is uncommonly great, so that the

period when it will be exhausted is yet very remote, and not easily calculated. In confirmation of which, I have to state, that, from investigations lately made, as to the quantity of workable coal in the estate of Newbattle, near Dalkeith, the property of the Marquis of Lothian, there is in it alone as much coal as would serve the city of Edinburgh, at the rate of 350,000 tons yearly, for the long period of 500 years. This statement I made from practical data and measurements, and it gives a very wonderful view of the aggregate quantity of coal in the Mid-Lothian basin. In this estimate many of the coals calculated are at a great depth, much greater than any coals have yet been wrought. There is, however, no doubt that the absolute necessity of having a supply of coals, the progressive improvement of the steam-engine, and of mining, will induce miners to adventure much deeper than the state of the coal-mines and present prices lead them to contemplate. There are yet no coal-mines working in Scotland above eighty fathoms deep; but in the vicinity of Newcastle coals are now working at the depth of 200 fathoms; and the engineers now contemplate going much deeper, and that is to be expected, according to the progressive improvement in mining.

Not thirty years ago, in working the Newcastle coals, from a fourth to a third of the whole coal was lost in pillars; whereas at present in the best regulated mines, only about an eighth part of the whole bed of coal is left under ground. This shews, in a strong point of view, how coal-fields may, within a certain limited area, produce much more coals than formerly from the same space,—simply by the improved system of conducting coal-mines, and that under a cover of rock 200 fathoms in thickness.

From this we may conclude, that the capital of Scotland is not likely to be in want of fuel for a very long succession of years; for, besides having the Lothian Coal-field, the Union Canal connects it with the Western Coal-fields; and the port of Leith connects with it the Fife, Stirling, and Clackmannanshire Collieries, and also those of the north of England.

On the Covering of Birds, considered chiefly with reference to the Description and Distinction of Species, Genera and Orders. By Mr W. MACGILLIVRAY, M. W. S., &c. Continued from former Number, p. 263.

FEATHERS, considered with regard to their uses, may be distinguished into two kinds. Those which are more especially employed as the medium of locomotion, are much stronger, more compact, and more elongated than the others. Of this kind is the row of feathers bordering the wing behind, and that terminating the rump or tail. The names of *quills*, *pennæ*, *pennes*, ought to be applied to these alike, although it is usually confined to the former. The feathers which lie immediately over the *wing-quills*, on both sides of the wing, partake in this respect of the nature of the quills themselves; but those which lie over the *tail-quills* are seldom, if ever, of so dense a texture. The rest of the feathers are not, in this most general sense, distinguished by any particular name in our language, although, by ornithologists who write in Latin, they are termed *plumæ*, and by the French *plumes*. The word plume, however, being with us the poetical name for a feather, or being used to designate such feathers as are applied to the decoration of hearses and heads, it cannot well be proposed as an ornithological term.

It has been mentioned that the accessory feather is always downy, excepting in those birds in which its developement is equal to that of the feather itself. It has also been remarked, that the part of the webs nearest the tube is always of a looser texture than the rest. In the feathers of many birds, the downy part occupies by far the greater portion; in some it is merely the tip that is compact, while in others the loose part is limited to a very small extent, and in others scarcely exists. As an example of feathers all downy, may be mentioned the subcaudal feathers of Pavo cristatus, and the abdominal feathers of Strix bubo, and owls in general. The abdominal feathers of Falco albicilla, and eagles in general, are nearly all of this loose texture. The gallinaceous birds have a very large proportion of down upon their feathers, and the Columbæ are the same in this respect. Of such as have very little down of this kind, may be mentioned

the different species of Aptenodytes. The crest feathers of Pavo japonicus are almost destitute of these soft barbs at the base; and this is, in general, the case with all those elongated feathers which, by the French, are termed *Plumes de luxe*, on whatever part of the body they grow. In quills, there is, in general, scarcely any downy part. In the downy barb, the filament is nearly equal in all its diameters, and is extremely attenuated. The barbules are also elongated, in many of the gallinaceous birds, for example, being twenty times the length of the barbules of the apicial part of the feather. These barbules are, in all cases, biserial, like the others, but very frequently they assume a direction the reverse of these, coming off from the filament, not in the plane of the web, but at right angles to it, or, in other words, from the face and back of the web, so as to present on these surfaces a layer of minute silky filaments. This arrangement is especially remarkable in the gallinaceæ. Frequently the filament becomes spirally twisted; in which case the barbs seem to have a circular arrangement, although they are still biserial.

With respect to relative magnitude, the following is an account of the ordinary distribution of feathers in birds. From the head, backwards to the tail, they increase in length and size; those on the face, or around the base of the beak, being smallest, the tail-coverts longest. The wing-feathers are much shorter than those of the body, and also increase backwards. Those of the upper or dorsal half of the body are almost always shorter than those of the under or abdominal; and the disproportion seems to have reference to the degree of obliquity of the body in its ordinary posture; for, in those birds which have a nearly vertical position, such as penguins, auks, guillemots, the feathers of the under surface are scarcely longer than those of the upper. The feathers of the upper parts are also more compact than those of the lower.

There is at least as great a difference as to size among feathers, as there is among the hairs of quadrupeds. The marginirostral feather of Trochilus moschitus is about one-sixteenth of an inch, while the middle caudal feathers of the Argus are three feet in length. In the same bird, also, the disproportion is often extremely great. For example, the frontal feathers of Pavo

cristatus are not more than a quarter of an inch in length, while some of the posterior dorsal exceed two feet. Even in the same part of two species of the same genus, the greatest difference is often observable in this respect. Compare, for example, the scapulars of Ardea cinerea and Ardea garzetta.

Besides the feathers properly so called, there enters into the constitution of the plumage or general envelope, another modification of the same general nature. On removing the whole of the feathers whose tips appear externally, in certain orders, and especially in the aquatic birds, we find the skin still covered with a more or less dense envelope of a very soft, filamentous, highly flexible, and very elastic substance. This is the *down, tomentum, duvet.* It also consists of individual parts, for which we have no general name in our language, nor indeed in any other that I am acquainted with. The name which seems most applicable to this sort of feather is *plumule.*

A *plumule, plumula, plumule*, consists of two parts; a small tube, less perfect in form and texture than in the feather, being very narrow, soft, and not well defined in its lower or proximal part, and having its walls composed rather of soft scales than of one continuous piece; and a pencil of filaments issuing from the base of this tube internally, without any connecting shaft. These filaments vary in length and number, according to the species. In all cases they are extremely slender, pliant, sinuous, and more or less spirally twisted. They consist of an extremely delicate shaft, along the sides of which there come off, in general, two sets of short delicate filaments. The former may be denominated the filaments, the latter the filamentules, corresponding to the barbs and barbules of the feather. These filamentules have the same relation to the filament, their shaft, that the barbules of the feathers have to their barb, and are, in general, equally distichous; but they enter into no connection, remaining perfectly loose, and, owing to the manner in which the shafts are twisted, have the appearance of coming off all round them. The general arrangement, as has been observed, is in two rows; in the down of Sula alba it is in three, one row consisting of filamentules somewhat shorter than the others, and directed toward the end of the filament. The filamentules of

the plumules, unlike the barbules of the feather, come off in general at right angles to the filaments.

The uses of the down are not well understood. As it is well known, however, to be a bad conductor of caloric, it is presumed that it serves in the aquatic birds, and particularly in those of cold climates, to retain the heat generated in their bodies. In birds which are not furnished with down, but which yet inhabit cold countries, the deficiency might be supposed to be supplied by the downy feathers which we observe in those birds, as in Strix bubo, Strix nyctea, Falco albicilla, and Falco chrysaetos. In the gallinaceous birds, the accessory feather might, in like manner, be imagined to be subservient to this purpose. But when we reflect that the eagles, owls, and gallinaceous birds of cold climates, are at least not much better furnished with down or downy feathers than species of the same genera inhabiting warm climates, we naturally look for some other reason for which birds are furnished with down; and when we observe that the Alca impennis of the arctic seas is not more plentifully supplied with plumage than the penguins of the pacific ocean, nor the Sturnus vulgaris of Europe than the Sturnus capensis of Africa, we suspect that other principles than heat have been employed in modifying the nature and quantity of the plumage.

In the gallinaceous birds, the omnivorous, and many others, in fact, in land birds in general, there is no general layer of down immediately covering the skin.

In the genus Falco, and many others, and especially in the larger species, F. albicilla, for example, F. chrysaetos, and F. peregrinus, besides down of the above description, there exist plumules of the following structure. From the upper part of a short tube, there issue two filamentary shafts, which are flattened, and exceedingly delicate. From these there branches out on either side a series of extremely delicate filaments, having each two lateral series of filamentules. The whole has the appearance of a single tuft of extreme fineness, and silky texture. The filaments have a very considerable degree of elasticity. The tube is open above, between the two shafts, there being a direct continuation of it on either side into the shafts; and at this opening the pith comes out and terminates. These plumules being largest on the belly, may be best seen there; they

exist, however, in the other parts of the body, but are not readily distinguishable from the down-feathers properly so called. If it be necessary to give these feathers a name, they may be called *Flake-feathers.*

In most birds, after the feathers have been removed, we find a sort of envelope, consisting of hairs as it were, set so widely and so small in themselves, that they might readily be overlooked. These are the hairs that are singed off in a common fowl after it has been plucked. In Phasianus colchicus their structure is as follows: from a very short bulbiform tube rises a very slender roundish piliform shaft, resembling a hair of the human head, but much smaller and straight, which, at the extremity, gives off two or three short simple barbs on either side. This is the most simple modification of the feather, if we except the quills of the Cassowary.

In all nestling birds, before they have received their full plumage, the skin is covered with a greater or less quantity of down, resembling that described above as occurring in adult birds. This down is generally more or less developed, even before exclusion from the egg. It consists of two orders of plumules. One set, which is connected solely with the skin, is similar in structure and relations to the down of the adult bird, each plumule consisting of a tube, out of which issues a pencil of filaments, furnished with filamentules. The other set, which, at first sight, is not distinguished from the former, being blended with it, is of the following nature. The plumules at first arise from the skin in the ordinary manner and form, but having fewer filaments than the others. Shortly after, when the feathers begin to sprout, they are observed to be elevated from the skin, being borne upon the tips of the feathers. The tips of the extreme barbs of the feathers are drawn together, and united into a point by a scaly envelope, similar to that which incloses the feather itself during the first stages of its growth. From this point there proceeds a pencil of filaments, consisting of a variable, but generally small number. These filaments have two lateral series of filamentules, and are loose and floating, and more or less spirally twisted. The filaments are continuous with the tips of the barbs, as is proved by discussing the point of adhesion with a needle, when the scales fall off, and the filaments remain attached to the tips of the barbs, and

continue so until rubbed off, which, in some species, and in certain parts of the body, the head, in particular, does not take place until the bird has been fully fledged.

To recapitulate, the plumage consists of *feathers*, properly so called, which are ordinary or quills, the former sometimes simple, more frequently furnished with an accessory feather; of *plumules* or down feathers; sometimes mixed with feathers having a structure intermediate between the double feather and plumule, and denominated *flake feathers*; and of piliform feathers, or feathers resembling hairs; the plumules, flake-feathers, and hair-feathers, being always, as well as in almost every case, the accessory feathers, concealed among the true feathers, the extremities of which alone form the surface of the plumage.

Having now briefly described the general structure of the plumage, I shall proceed to the particular details, which may be rendered subservient to the purposes of description and classification. And, in the *first* place, it will be necessary to define the situation of the feathers, denominating them according to the parts of the surface on which they are placed.

Considered with respect to situation, feathers may be named as follows:

CAPITAL, *on the Head.*

Frontal, on the fore-part of the head.
Vertical, on the upper-part of the head.
Occipital, on the hind-part of the head.
Genal, on the side of the head, under the eye.
Loral, on the space between the beak and the eye.
Marginirostral, round the basilar margin of the beak.
Upper marginirostral, at the base of the upper mandible.
Lower marginirostral, at the base of the under mandible.
Auricular, about the aperture of the ear.
Palpebral, on the eyelids.
Ciliary, on the edges of the eyelids.

CERVICAL, *on the Neck.*

Posterior cervical, on the back-part of the neck.
Anterior cervical, on the fore-part of the neck.
Lateral cervical, on the sides of the neck.

Each of these may be subdivided into upper, middle, and lower.

ON THE BODY.

DORSAL, *on the Back.*

Anterior dorsal, on the part of the back nearest the neck.

Middle dorsal, on the middle part of the back.

Posterior dorsal, on the part of the back nearest the tail.

PECTORAL, *on the Breast.*

Anterior pectoral, on the fore-part of the breast.

Middle pectoral, on the middle-part of the breast.

Posterior pectoral, on the part of the breast next the belly.

Lateral pectoral, on the sides of the breast.

ABDOMINAL, *on the Belly.*

These may be divided according to their relative situation; but this is scarcely necessary.

HYPOCHONDRIAL, *on the sides of the Body under the Wings.*

The same remark applies to these as to the abdominal.

ALAR, *on the Wings.*

Upper Alar, on the upper part or dorsal aspect of the wings.

Under or *Lower Alar*, on the under part or sternal aspect of the wings.

These feathers are usually termed wing coverts. The name is absurd, because all feathers are coverts, and the cervical or dorsal feathers might as well be called neck coverts and back coverts.

Alar Quills, feathers growing from the posterior edge of the wing. These are best defined according to their connection with the bones of the wing.

Primary Quills, the first ten, counting from the outer end of the wing, situated upon the digital and carpal bones.

Secondary Quills, those situated upon the brachial bones.

Tertiary Quills, those situated along the humeral bone.

Quill Coverts, a row of feathers immediately covering the base of the quills. They approach in compactness and strength to the quills, and may, therefore, with propriety be distinguished from the other wing feathers.

Primary, *secondary* and *tertiary Quill Coverts*, according to the rank of the quills over which they lie.

Upper and *Under Coverts*, on the dorsal and sternal aspect of the wing.

Scapulars, a bunch of long feathers, situated at the proximal extremity of the os humeri on the back.

Axillary feathers, a bunch of long straight feathers, situated at the proximal extremity of the humerus, under the wing.

ON THE LEGS.

Tibial, feathers covering the tibia, or what in ordinary language is called the thigh.

Tarsal, covering the tarsus.

Digital, covering the toes.

CAUDAL, *on the Tail.*

Caudal feathers or rather *Quills*, feathers terminating the body behind.

Caudal Quill Coverts, upper and lower, feathers covering the caudal quills at their base, above and beneath.

A Tour to the South of France and the Pyrenees in the year 1825. By G. A. Walker Arnott, Esq. F.R.S.E. F.L.S. M.W.S. &c. (Continued from former Volume, p. 356).

Having remained two days at Perpignan, to dry, pack up, and send off the plants we had by this time gathered (to the amount of 7600 specimens), we set off on the 10th June for Arles in Roussillon.

As the distance of Arles from Perpignan is not very great, we arrived in sufficient time to make a short excursion to a hill a little to the south of the village. It was in this walk that we first began to meet with Pyrenean plants, more strictly speaking, as those we had already seen are to be found all around the Mediterranean. On this hill we found the *Ramondia pyrenaica, Passerina dioica, Antirrhinum asarinum, Teucrium pyrenaicum, Achillea odorata*, and *Globularia nana.* This last is usually united to *G. cordifolia ;* but if they be not distinct species, they are certainly most marked varieties. In all the herbaria I have examined, I have never seen one specimen of *G. nana* from Switzerland; and, on the other hand, the *G. cordifolia* is so extremely scarce in the Pyrenees, that I have only observed it in one spot, the Port de Benasque. I have also a specimen of the *G. nana* from the garden of Perpignan, much larger than the usual size of the wild plant; but even cultivation does not shew the characters of the Swiss plant. Among the Acotyledones, we observed little worthy of notice. *Aspidium Halleri* and *Hypnum rugolosum*, W. M. may, however, be mentioned.

On the 11th, having experienced wretched accommodation, we quitted Arles at an early hour. Approaching now the mountains, we found the roads no longer practicable for wheel-carriages. We therefore resolved in future to travel almost entirely on foot, followed by mules, to carry the paper, plants, and provisions we found necessary to transport from station to station. Notwithstanding we had left Arles by five, the sun was already very hot, and annoyed us excessively, and that, joined to the number of good plants we gathered along the road, retarded us so much, that we did not arrive at Prats de Mollo to breakfast till one o'clock. In this course, we observed for the first time *Prunella grandiflora, Silene nutans, Veronica*

urticæfolia. *Medicago suffruticosa* * occurred in the bed of a torrent. But what principally delighted us, was *Cardamine latifolia*, and a new species of *Santolina* (*S. pectinata*, Benth. Cat.). This is a remarkable species, closely allied to *S. alpina* and *S. eriosperma*, and agreeing with them in having the leaves pinnatifid, but differing in being a shrub, and having the scales of the involucrum nervose and slightly pubescent.

Prats de Mollo is a very pretty small town, situated in an agreeable and picturesque valley.

With the exception of a short walk the evening of our arrival along the banks of the river that passes the town, in which we found *Scrophularia Scopolii*, *Thalictrum aquilegifolium*, *Saxifraga rotundifolia*, *Cardamine latifolia*, *Lamium stoloniferum*, Lap. (which is certainly the same with *L. maculatum*, Linn. and *L. hirsutum*, Lam.), and *Bunium pyrenaicum*, Lap. (*Myrrhis pyrenaicum*, Spr. but not distinct even as a variety from the common *M. Bunium*, Spr.), we made no excursion but to the Tour de Mir, an old watch-tower on the summit of the hill to the south of the town. As Prats de Mollo is about 500 toises above the level of the sea, and the Tour de Mir is still more considerably elevated, I should not suppose it to be at a less elevation than 4000 feet, and of course we expected plants of a somewhat different description than we had as yet encountered. On our ascent, we deviated slightly from the road, to seek for the *Sedum divaricatum*, Lap. and *Orobanche pruinosa*. The former was not yet in flower; but notwithstanding the long argument held forth by Lapeyrouse in the Supplement to the "Histoire abrégée des Plantes des Pyrenèes," it was perfectly clear that De Candolle was right in saying that it was identical with *S. saxatile* of other authors †. As to *Orobanche pruinosa*, this locality was interesting, as being the only one in France, and the only one known to Lapeyrouse when he described the species. The plant had, however, been imported along with beans from Catalonia; and it is not probable that the farmer here shall

* The flowers of this are yellow, not blue, as Lapeyrouse says. Can his *M. tornata* be the same plant?

† Such I state as my own opinion, after a careful comparison of numerous specimens gathered principally in the Vallée d'Andorre, with the Swiss *S. saxatile*. My friend Mr Bentham, however, considers the two as very distinct.

ever be rid of the nuisance, unless he takes the advice we gave him, that he should refrain from sowing beans in the neighbourhood for at least a season, and at the same time procure new seed from a distance. Soon after leaving the farm on which these plants are found, we met with *Ramondia pyrenaica* and *Erinus alpinus*. *Hieracium auricula* was also in the neighbourhood; and on some rocks near the summit *Globularia nana* was abundantly in flower. But the most interesting plant we observed was *Saxifraga media*, Gouan (*S. calyciflora*, Lap.), which was abundant in the crevices of the walls of the tower; and along with it also on the summit, are found *Moehringia muscosa*, *Lonicera pyrenaica*, *Festuca flavescens*, and *Valeriana tripteris* and *montana*. These two last are surely but one species: they here were mixed together, with innumerable states between them. On our descent, we also observed several plants of interest, as *Avena versicolor*, DC. (*Av. sempervirens* *, Lap. and Vill. not Schrad.), *Helleborus viridis*, *Arabis alpina*, and *Alchemilla hybrida*, Hoffm. or *A. pubescens*, Lap. Notwithstanding the elevation, it will be seen that the plants were not very alpine.

During the few days we made Prats de Mollo our head quarters, we experienced the utmost kindness and attention from M. Xatard, *Juge de Paix* of the canton. He has been long occupied with the botany of this department of the Eastern Pyrenees, and it was he who furnished Lapeyrouse with all the plants he has cited to grow about Collioure, Bagnols, and Prats de Mollo. He not only allowed us to examine his herbarium, in order to determine some of the plants that Lapeyrouse had in view, but procured us the guides whom he himself usually took, and who were con-

* *Av. sempervirens* has, in some way, got strangely confounded with *Deyeuxia sedenensis*, Clar. although in this last there is only *one* fertile floret accompanied by a sterile one, or subulate pilose process, as is well represented in P. de Beauvois' figure, and which accords precisely with my specimen. *Av. longifolia*, Thore, has also been confounded with *Av. sempervirens*, but its glumes contain only two florets, and only one of them is provided with an awn or *arista*. I may here mention, that *Deyeuxia sedenensis* does not appear to me to differ from *D. montana*, the figure of which last in Pallissot, is not correct. Several other species of what are put into the genus *Calamagrostis*, have the twisted geniculate awn; and the whole of that genus, having the inner valve of the corolla bicarinate, has been erroneously arranged by Kunth near *Agrostis*.

sequently acquainted with the localities, and even with the plants we were chiefly in quest of. One peasant we dispatched to the Hermitage of St Andiol, to procure us the *Lithospermum oleæfolium*, while another was sent off to the Bac del Fau, to gather the *Anthyllis erinacea*. Both these localities are at a considerable distance, and on the Spanish frontier. The first of these guides returned with a good cargo; but the other informed us that the plant was not in flower, but that he had pulled off the *seed*, and brought it. A moment's inspection of the contents of his box shewed that the plants had been in flower, for the *fruit* he had gathered was the inflated calyx. Our disappointment was no doubt great, but it was resolved to send off the man again the following morning, with one of our party, while the others should be employed in arranging and drying what plants we already had. This second attempt was successful, notwithstanding the badness of the day. The *Anthyllis* formed hemispherical masses on the ground, the spinous and rigid branches rendering it very difficult to be laid hold of, without the aid of a sharp hook attached to the extremity of a cane, and with which it might first be cut to pieces. The guide yesterday had destroyed the greater part of the flowers, so that Bentham, who volunteered this excursion, only procured the young fruit. At the Bac del Fau, Mr Bentham met with nothing else of note, unless *Campanula speciosa*, *Ramondia pyrenaica*, and *Onosma echioides* be mentioned as such. The guide who went to St Andiol brought with him a specimen or two of our new *Santolina*.

Prats de Mollo is one of the best points for a botanist's residence in the Eastern Pyrenees. But in order to examine the warm valleys on the Spanish side of the mountains, one ought to be there a few days earlier than we were; while, again, to botanize on Costabonna, and the other elevated mountains in the neighbourhood, one must be at least a fortnight later. To make the excursion in search of the *Anthyllis*, which ought not to be neglected, one ought, on account of the distance and frightful roads, to sleep at St Laurent de Cerda, or at Custojà, and devote to it at least three days; nor would the excursion to St Andiol require less.

On looking over M. Xatard's herbarium, principally named by Lapeyrouse, we observed many mistakes which that author has made in his "Histoire abrégée." His

Bromus glaucus	is	*B. erectus.*
——— *geniculatus*	...	*Festuca myurus.*
Hedysarum herbaceum	...	*Onobrychys supina.*
——— *crista galli*	...	——— *caput galli.*
Ranunculus Xatardi	...	*R. trilobus.*
Stachys barbata	...	*S. heraclea.*
Centaurea cærulescens	...	*C. maculosa.*
Galium suaveolens / ——— *megalospermum* / ——— *cometerhizon*	is	*G. villarsii*, Req.
——— *papillosum*	...	*G. læve.*
Phyteuma Scheuchzeri	...	*P. orbicularis.*
Poa serotina	...	*P. trivialis.*
Trifolium gemellum	...	*T. Bocconi.*
——— *vesiculosum*	...	*T. resupinatum.*
——— *Xatardi*	...	*T. maritimum* *.
——— *intermedium*	...	*T. hybridum*, Savi ‡.

On the 14th June, having packed up and sent by the more common and accessible road the greater part of our baggage, we left Prats de Mollo, accompanied by a mule, loaded with as much paper and provisions as might suffice for three days for the whole party, and a guide to conduct us across the Canigou to Prades. After experiencing some inconvenience from stormy weather, we at length reached the Hermitage of St Guilhem. The view from the top of the ridge was extremely fine, extending a great way down the valleys and the lower Pyrenees to the east, or rather, I may say, to the Albères mountains. At the summit of this ridge, too, the vegetation was changed in a great degree. We now observed truly alpine plants, among which were *Polygonum alpinum*, *Thymus alpinus*, *Epilobium alsinæfolium*, and *Jasione humilis*. This last species, I may remark, has been confounded by some with *J. perennis*, but really appears very distinct. *J. perennis* has, on the other hand, been united by some to *J. montana*, but that is an annual species. I do not know what Sir J. E. Smith's opinion is; but even in his

* Mr Bentham remarks with justice, in his Catalogue, p. 125. that *T. Xatardi* var. *α.* in DC. Prod. is precisely the *T. maritimum*, but that his var. *β*, or *T. bœticum*, seems a distinct species.

‡ The *Tr. hybridum*, Savi and DC. Prod. is not *T. hybridum*, Linn. To the last *T. michelianum*, Savi, is a synonym. For the plant in question, therefore, the name given by Lapeyrouse, *T. intermedium*, must be retained, and the *T. intermedium*, Gussone and DC. Prod. must (if a legitimate species) be new named.

late work, he has given no specific character to *J. montana*, thereby seeming to declare that there is but one species of the genus.

We obtained shelter during the night in the hermitage. As the morning was very foggy, and the rain continued to fall in torrents, we did not dare to attempt the passage of the Canigou, but contented ourselves with gathering what we could in our vicinity; and there were, indeed, some species that were prized very much. *Convallaria verticillata*, *Orchis ustulata*, *Urtica hispida*, *Asphodelus albus*, and *Lilium pyrenaicum*, were all of them desirable. *Scrophularia Scopolii* and *Quercus microcarpa*? Lap. also occurred*, and likewise *Apargia hispida*.

About mid-day, the mist cleared away, and the weather began to improve, so that we now resolved to cross the Canigou. On our ascent, we found a great many alpine plants: *Gentiana acaulis verna*, *Primula integrifolia*, *Aretia carnea*, and *Ranunculus pyrenæus*, covered all the wet banks, and *Trifolium alpestre* all the dry. The plants we observed to extend to the greatest elevation, were *Aretia carnea* and *Sempervivum montanum*, not yet in flower; the leaves of the latter were covered with *Uredo sempervivi*.

* I may mention, that, we also observed here, as well as on our ascent to the Treizabents, *Veronica fruticulosa*, var. Linn. and Sm. (a variety of *V. saxatilis*, Lap. DC. Fl. Fr., and Hook. Fl. Scot., but not so according to Smith, nor, apparently, Brown). This, which appears to be the plant found on Ben Lawers in Scotland, and which, alone, of the allied species, we found (and that not merely in different places on the Canigou, but also in the Vallée d'Eynes, and on the ascent to the Port Negre in the Vallée d'Andorre,) in the Pyrenees, is nearly intermediate between the true *V. saxatilis* and the cultivated *V. fruticulosa*, which last, alone, is that of De Candolle, and agrees with Haller, Helv. t. 15. The only character, however, that I can see between *V. fruticulosa* and *saxatilis*, is, that in the former the leaves are always somewhat lanceolate (though often at the same time obtuse and entire), and in the latter they are nearly round or ovate. In *V. fruticulosa*, the peduncles are scarcely so long as the bracteas, while in the other, they are usually much longer, which gives the spike, or rather raceme, a lax appearance. I have only to add, that the cultivation of *V. saxatilis* of Scotland for three or four years in my own garden at Arlary, has so much approached it to the Pyrenean plant, that, had I not, I think with considerable accuracy, ascertained on the subject the opinion of Sir J. E. Smith, I should have preferred uniting the latter to *V. saxatilis*, if, indeed, *V. saxatilis* and *fruticulosa* be really distinct species. From *V. saxatilis*, the *V. nummularia*, Gouan (*V. irregularis*, Lap.), differs, by its narrow petals.

In addition to what I have mentioned as the more common, we found scattered the *Iberis garrexiana* (I cannot believe that this differs from *Iberis sempervirens*), *Plantago sericea*, W. et K. *Cardamine resedifolia*, *Spergula saginoides*, *Pyrethrum alpinum*, and *Primula viscosa*, all which we procured as we followed the mule along the footpath to the summit of that part of the mountain called the Treizabents. The scene at this point was grand. Our view extended far down into Spain, to Girona, Figueras, and the Bay of Rosas. Looking back towards the hermitage, we had at some distance on our left the true summit of the Canigou, about 300 feet still above us; but as the snow seemed newly melted from off it, and no appearance of vegetation, we felt no inclination to go out of our road, for the sole purpose of mounting to the top. On our right was another point of the mountain called the Sept Hommes. The highest part of the Canigou is said to be about 1450 toises, or 8700 feet above the level of the sea: it is the most elevated mountain in the Pyrenées orientales, and is seen even from Montpellier.

We now descended the north side, and, though we found again several of those we picked up in our ascent, yet, comparatively speaking, few specimens were in flower, owing to the large masses of snow that still lay unmelted. According to our guide's account, there was even more snow now than had been a month before, owing to a second storm. Indeed, we saw proofs of it in the beautiful *Senecio leucophyllus*, which apparently had almost been in flower before the last storm came on, but that so buried it beneath the snow, and checked its progress, that, even at this advanced season, we could not procure one good specimen. As, however, we came down to the more sheltered and warmer spots, we found abundance of other plants, among which were *Sisymbrium pinnatifidum*, *Anemone alpina* var. *sulphurea*, *Rhododendrum ferrugineum*, *Paronychia polygonifolia*, *Reseda sesamoides*, besides the *Azalea procumbens* * in profusion. At length, after a fatiguing, if not a long walk, we arrived at Cady, a small summer cabin for the shepherds at the entrance of the wood, and at the base of the principal summit of the Canigou.

Having passed here a pretty good night, thanks to the fa-

* I agree with Mr Don in thinking this to be the only legitimate species of *Azalea*, and that all the others form a section of *Rhododendron*.

tigues of yesterday, to some armfuls of straw that the shepherds had left last year behind them, and to th[illegible]res we kept up all night both outside and inside the hut, we commenced the labours of the 16th at break of day, by gathering specimens of *Ranunculus montanus* and *Stellaria cerastoides* that were growing before our hovel, and at a short distance *Genista purgans.* As we alternately ascended and descended through the wood, we procured very few plants worth mentioning (among them, however, were *Linaria alpina, Lonicera nigra, Ribes petræum, Saxifraga geranoides,* and *Apargia alpina),* but were well recompensed by the delightful and varied views we had. The finest perhaps of all, was at the summit of the last slight eminence we mounted, before beginning our rapid descent to the country below. Behind us was the Canigou, with its bare rugged tops, and snow lying in the ravines: on the one side was the Pla Guilhem, and on the other a steep bank, with a torrent and cascade at the bottom, beyond which were a series of *aiguilles,* or needle-shaped ridges, boasting only of a few straggling trees of the *Pinus uncinata* (the common pine of this mountain); before us lay a long and winding descent towards Vernet. Before we arrived at Vernet, we saw on the left perched up on a ridge of the mountain the St Martin de Canigou, inhabited by a hermit. The castellated appearance of the house, which is of a pure white colour, has a fine effect from the road, and on the whole renders it a much more desirable place of residence than the hermitage of St Guilhem, at which we slept two nights ago.

On our descent, we observed *Sambucus racemosus, Potentilla rupestris, Viola biflora* (the scapes were uniformly 1-flowered), *Urtica hispida, Festuca spadicea, Prunella grandiflora,* and *[illegible]ba nemoralis,* and close to Vernet *Sempervivum arachnoideum.* We reached Vernet about three o'clock, and, after the delay of an hour or two, in which time we procured with difficulty some refreshments, we pushed on, and, passing Villefranche, arrived at Prades about eight o'clock in the evening. Villefranche is a remarkably strong place; not only does the fort on an eminence command the town, but the only passable roads to Vernet and Mont Louis pass through it. The gates of the town are also shut every evening at nine. Between Ver-

net and Villefranche we found *Quercus tauzin*, *Hypecoum grandiflorum*, Benth. and *Myosotis lappula*, and about Villefranche *Galium maritimum*! *Bupleurum fruticosum*, *Cnidium pyrenæum*, Spr. and *Galium læve*.

At Prades we made acquaintance with M. Coder, a zealous botanist, who, during our stay at this place, procured us every possible facility for the excursions and researches we had to make. Like M. Xatard of Prats de Mollo, he opened to us his collection of plants, particularly of the department we were in, and shewed us also several specimens that had served M. De Lapeyrouse wherewith to make several of his species. He accompanied us also in a part of our excursions, and got us excellent guides for the others. The most important we made were to the Trancade d'Ambouilla and the Font de Comps. The former is close to Villefranche, and, with the assistance of M. Coder, we procured a few good plants, though the greater part had long since done flowering:—*Salsola prostrata*, *Buffonia perennis*, *Galium glaucum*, *Lysimachia ephemerum*, *Genista hispanica*, *Antirrhinum latifolium*, all occurred here. *Bupleurum petiolare*, Lap. a mere variety of *B. falcatum*, was also met with. One specimen was got in an advanced state of *Orobus filiformis* *, Lam. and a few of *Alyssum halimifolium*. This plant, though De Candolle quotes this exact locality for his *A. macrocarpum*, is nevertheless the true *A. halimifolium*, Linn. at least it accords precisely with what is found under that name in the maritime Alps; but *A. pyrenaicum*, Lap. is, on the other hand, a variety, if not identical with the true *A. macrocarpum* from the Cevennes, as De Candolle properly judged in the Supplement to the "Flore Française," but which, by some mistake, he has kept up as a good species in his "Systema. †"

* Mr Bentham refers this to *O. albus*, but Seringe in DC. Prod. to *O. canescens*. My specimen is too far gone for me to determine to which it belongs. I may state here, that, in the three first varieties of *O. canescens* of Ser. the alæ of the corollæ are in part soldered to the carina, which is not the case with *O. albus*. The style in his var. γ is nearly linear; but in his var. β, it is extremely broad towards the apex. Perhaps this last is a distinct species, and to be referred to *Lathyrus*.

† At the Trancade d'Ambouilla, we also met with *Hippocrepis comosa*. I merely mention the circumstance here, in order to state what Mr Bentham and I only ascertained lately, that *Hippocrepis scorpioides*, Req. in Benth. Cat. and in the former part of this journal, is identical with *H. glauca*, Ten.

The excursion to the Font del Comps was made by two of the party only, the other remaining at Prades, to change the plants; and indeed those who remained behind were the most fortunate. About mid-day, as had been the case every day for upwards of a week, a thunder-storm commenced, with so much rain, that those who collected the plants were obliged to take shelter in caverns the greater part of the time they were out on the mountain; and it was with the utmost difficulty a very few specimens of *Alyssum pyrenaicum*, Lap., *Lavandula pyrenaicum*, *Senecio doronicum*, *Linum alpinum*, *Globularia nudicaulis*, *Adonis flava*, *Passerina dioica*, and *Cynoglossum sylvaticum*, were procured. The last plant alluded to, seems to be the true *C. sylvaticum*, Hæncke (*C. Hænckii*, R. & S.), in which the carpels are rugose between the bristles. *C. sylvaticum*, Sm., on the other hand, is identical with *C. montanum*, Lam. (a name which must therefore be retained), and has the fruit even (*lævis*) between the bristles: with Lamarck's plant must also be ranged *C. pellucidum*, Lap. *Dracocephalum austriacum* was sought for diligently, but without success. *Saxifraga media* and *Onopordum pyrenaicum* were, however, observed. The mountain takes its name from a small spring, close to where the best plants were found, so very inconsiderable as scarcely to supply water enough for breakfast.

While these expeditions were made by ourselves, we dispatched a guide whom M. Codère was in the habit of employing in a similar way, to Serdynya, to bring us a panier full of *Onopordum pyrenaicum*: he returned with nothing else. This plant differs essentially from the *O. acaulon*, Linn., that having one large sessile flower in the centre of the leaves, whereas the Pyrenean plant has at least ten or a dozen, also sessile, among the leaves.

On the 21st, after some days residence at Prades, MM. Requien and Audibert, finding that they could not afford time sufficient to penetrate farther into the mountains, determined to return home by Perpignan, whilst Mr Bentham and I should continue our course to Mont Louis. We accordingly set about making preparations, in order that we might separate the following morning.

(*To be continued.*)

Account of Harris, one of the Districts of the Outer Hebrides. Communicated by the Author *.

AT a short distance from the mainland of Scotland, and along the western shores of its northern and middle divisions, lies scattered an interrupted series of islands of various sizes. These are denominated the Inner Hebrides. Beyond these, and separated from them by a channel, called the Minch, of variable breadth, from fifteen to forty miles, is extended a continuous range of islands, consisting of five principal masses, with a prodigious multitude of small islets, from three or four miles diameter to a few yards. The direction of the range is north-east and south-west. From the Butt of the Lewis, the most northern point, to Berneray of Barray, otherwise called Barra Head, the most southern, the distance is about 130 miles. It is bounded on the east by the Minch, on the west by the Atlantic Ocean. The districts of this range are the following:—Lewis, Harris, North Uist, Benbecula, South Uist, and Barray. Lewis, the most northern, and Harris, form but one island. The others are distinct islands, although a passage at low water may be made from North Uist to Benbecula, and from the latter to South Uist, over the sands by which they are separated.

The mainland of Harris is about twenty miles long, and is naturally divided into two districts. The northern, joining Lewis at a boundary of about eight miles, extended from the head of Loch Resort on the west coast, to the turn of Loch Seaforth on the east, and uniting with the southern at an isthmus named Tarbert, about a quarter of a mile across, consists of a range of lofty, rugged, and sterile mountains, running from east to west, or nearly at right angles to the general direction of the island. One of these mountains, named Clisheim †, is the

* Read before the Wernerian Natural History Society, December 1827.

† Dr Macculloch, who gives this mountain the name of Clisseval, estimates its height at 2700 feet. He found that of Langa, in its neighbourhood, to be 2407, and, if this be correct, Clisheim, being apparently at least 800 feet higher, is probably nearer the above estimate than the Doctor's.

highest ground in the Outer Hebrides; and appears to be somewhat upwards of 3000 feet above the sea. This mountain range is crossed by several deep valleys, on the sides of which, and in other places, are some of the most magnificent rocks to be seen in Scotland. The pass of Miavag presents a terraced precipice about 1000 feet high; and in the Glen of Ulladil, there is a rock, of not much less elevation, at one place overhanging its base many yards. These mountains are in general bare and rocky. The soil is universally peat of different varieties, and the vegetation consists chiefly of heath, with carices, junci, scirpi, and an abundance of lichens. In the whole of this tract there is not a piece of good arable land of the extent of four acres. There are several lakes in the valleys, at various altitudes, and of various sizes, none exceeding two miles in length. The water of all these lakes is of a deep-brown colour, as is that of the numerous rills and brooks which descend from the mountains. There is at present no wood, although the roots and stumps of the common fir are seen in many places. At the eastern extremity of the range is the low, swampy, and heathy island of Scalpay, on the point of which, that projects farthest into the Minch, is built a lighthouse; and at the western extremity, the high and rocky island of Scarp, both separated by a very narrow channel. There are many other small islands, especially on the eastern side, which it is not necessary to enumerate. The shores are rocky, but in general low. Many of the harbours are excellent; those of Scalpay, more generally known among mariners by the name of Glass, are well known, as well as East Loch Tarbert; but there are others equally good to the west of Tarbert, and in fact round the whole district. This division is in the country termed Na Beannibh, *i. e.* the mountains. It is also called the Forest, not probably so much on account of its having been formerly wooded, as because it was the resort of great numbers of red deer.

The other, or southern division of the mainland of Harris, commences at the isthmus above mentioned, which in many maps is erroneously made the boundary between Harris and Lewis, and extends to the channel which separates Harris from North Uist. It is entirely mountainous, but the mountains are not so high as those of the Forest, the most elevated, Ronaval,

Bencapval, and Ben Loskentir, not exceeding 2000 feet. The aspect of this region, as seen from the Minch, is singularly uninviting, almost the whole surface appearing to consist of bare white rock. Indeed, a more perfect picture of sterility can scarcely be imagined. Viewed from the west, however, this district has a very different appearance, the shores being in general sandy, and the hills for the most part covered with a green vegetation. Along the east coast, which is everywhere rocky and low, there are numerous inlets and creeks, here denominated bays, that word being supposed to correspond to the Gaelic *baigh*, which latter, however, appears to be nothing else than a corruption of the Danish *vöc*. Many of these afford good harbours. Many small islands lie along this coast. The southern shore partakes in a great measure of the nature of the eastern, being rocky and low, but toward the west side it exhibits a few sandy beaches, and ends in a tremendous precipice, with a high neck of land running out from it, in which there are two fine caves. On the west coast there are, besides several sandy beaches, two great sands or fords, as they are here called, namely, the sand of Northtown and that of Loskentir. They consist of nearly level expanses, each extending upwards of a mile from the sea. At their mouth there is a long bar formed by the surf and winds, broken only in one place, close to the adjacent rocky land, where a channel is formed, which admits the waters of the sea at each tide. These, at spring-tides, cover the whole sands. The rest of the coast is rocky, but low, excepting toward Tarbert, where there are tremendous cliffs. This division is intersected by two great valleys, one passing from the sand of Luskentor to the east coast, the other from the farm of Borg. The bottom of a great portion of the latter is occupied by a lake about three miles long, the largest in the district. There are thus formed three natural subdivisions; that to the south of the lake mentioned consists of six mountains, including the peninsular one of Ben Capval, which are separated by broadish valleys. The vegetation here is tolerable, excepting on Ronaval, which is rocky and bare, and exhibits on its eastern side a fine excavation, resembling the crater of a volcano. It is chiefly heathy, however, excepting along the west side, where the pasturage is rich and varied. The middle division, from Loch Langavat to

the northern valley, is marked by a ridge of very rugged mountains, running in the general direction of the range, and situated nearer the western side. Along the west coast of this subdivision, there is some good pasture, but on the eastern side, the only soil being peat, and even that existing only in patches among the rocks, the vegetation is extremely coarse and scanty. From one of the summits of the ridge mentioned, I have counted upwards of eighty small lakes on its eastern side. The northern subdivision consists of Ben Loskentir, which gradually lowers to the eastward. The lakes in the low grounds on its eastern part are also extremely numerous. The water of all these lakes is brown. There are no harbours on the west coast of this southern division of the mainland of Harris, and it is even very difficult for boats to land on the beaches, owing to the high surf. It possesses no sylvan vegetation, excepting a few bushes in ruts and on islets in the lakes. The principal island is Taransay, on the west coast, the greater part of which is rocky, although it contains good pasture. This division has no general name applied to it in the country, but its western part is called the Machar, *i. e.* the sandy district, and its eastern, Na Baigh, the Bays, or more correctly the Voes.

The Mainland of Harris is separated from the large island of North Uist, by a channel about 8 miles broad, denominated the Sound of Harris, over which lie scattered a prodigious multitude of islands and rocks, interspersed with reefs, shoals and sand-banks. Of these islands only four are inhabited: Pabbay, Berneray, Kelligray and Ensay. Pabbay, the most western, is a high conical island, about 2 miles in diameter, rocky in its northern and western parts, sandy on the eastern, and pretty well covered with good soil on the southern, which is low. Berneray lies to the south of Pabbay, at the distance of about 3 miles, and is situated close upon Uist, the intervening channel, about a mile over being named the Kyle or Strait of Uist. It is about 4 miles long, and from 2 to 1½ broad. The western coast is sandy, and along it, as well as on the east coast of Pabbay, the sand has committed frightful ravages. The rest of the island is in general fertile, and the pasture grounds are covered with a fine, short, green vegetation. To the east of Berneray lies the small island of Kelligray, which is low, sandy and fer-

tile at its northern end, heathy and covered with peat at the southern. To the north of this island, and separated by a narrow and most rapid and boisterous channel, is the island of Ensay, which is perhaps the finest of its size in the Outer Hebrides, being covered with a beautiful vegetation, and for the greater part cultivated. To the eastward of these larger islands lie a multitude of smaller, which, extending from the mainland of Harris to the immediate vicinity of North Uist, present, from their number and diversified appearance as to size and form, one of the most singular scenes that occurs on any part of our coasts.

Hydrography.—The ocean exhibits no other appearances than such as are common to the west coast of Scotland in general. From the prodigious swell that follows a western gale in winter, to the glassy smoothness of a summer sea, there are many varieties of surface operated, but these require no particular notice. The bottom of the sea is generally sandy along the west coast, and in the sound; in some parts sandy, in others muddy or gravelly on the eastern coast, with numerous sunk rocks, reefs, and shoals. The water is always clear, even after a storm. The bottom may be seen to a great depth, and where it is sandy, it is pleasant to look down and watch the motions of the great shoals of sandeels, cuddies (Ammodytes Tobianus and the fry of Gadus carbonarius) and other fishes, or from an elevation near the beaches to observe the mergansers, shags, divers, and other aquatic birds pursuing them under the water, with almost incredible velocity, and using the same motions as if flying in the air, only that the feet as well as the wings are called into action. In the sound the currents are extremely rapid, and at spring-tides, when they have to contend with a contrary gale, rise into short and jumbling waves, highly dangerous to boats. A most violent agitation of this kind is also produced when a great swell rolls in from the west meeting the stream of ebb. I need scarcely mention that in the sound, the flood passes eastward into the Minch, and the ebb westward into the ocean. In autumn the sea swarms with Medusæ of various species, some of enormous size. Some of these emit at night a beautiful pale light resembling an electrical flash, seeming to permeate, or be emitted by, their whole substance. The usual sparkling lumi-

ousness of the sea is also frequently very remarkable at that season.

Wrecks are not frequent on this most boisterous and rugged coast, because it is out of the line of navigation between North America and the west coast of Scotland, and the east coast, along which a considerable number of vessels may often be seen passing, is provided with abundance of good harbours. Logs of various kinds, chiefly fir, pine, and mahogany, are, however, frequently cast ashore on the west coast, with occasionally a hogshead of rum or sugar, as well as bales of cotton and bags of coffee. Several species of nuts from the West Indies are not unfrequently found along the shores, as well as a few foreign shells, such as Janthina fragilis and Spirula Peronii. Pumice and slags also occur in small quantities, and I have seen pieces of bituminous wood found on the shores, resembling the surterbrand of Iceland, which renders it probable that these substances may have come from that island.

Being on the subject of water, it may not be amiss to say a word respecting the lakes and brooks. Of the former, I need only add to what has already been said, that, in most cases, their bottoms are gravelly, or consist of angular or rounded pebbles, intermixed with mud, and sometimes muddy, or of peat. The streams are in winter seen gushing from every hollow in the hills; but in summer there are few that remain permanent, if the weather continue dry for many weeks, which, however, is seldom the case. There are no rivers of any great size: that which empties itself into Loch Resort, however, is at least equal to the Water of Leith, and there are several others not much inferior. Springs are by no means rare, although all that I have seen are small. Many of them are chalybeate *.

* In the island of Pabbay, there are at least ten springs, some of them pretty large. In the peninsula of Ben Capval, there are five. From Cosladir to Nisbost, along and close to the road, in a line of 5 miles, there are five good springs. In as far as I have been able to observe, the rest of the country is equally supplied with springs; but Dr MacCulloch perhaps thought it necessary to suppose that spring water should not exist in the Outer Hebrides, because the rock there being every where the same "eternal gneiss," the rain waters were unable to penetrate it. This, to use the Doctor's own

Climate.—The climate of Harris may be said, in a general sense, to be extremely varied; for a great part cold and boisterous, with a very large quantity of rain, and but little snow, considering its high latitude *. Spring commences about the 20th of March, when the first shoots of grass make their appearance, and the Draba verna begins to unfold its small white blossoms. It is not until the end of May that the pasture-grounds have fairly exchanged the grey and sad livery of winter for the green and lively hue of summer. From the beginning of July to the end of August may be considered as the summer season, when the sandy pasture-grounds of the west coast and islands are decorated with the most diversified hues. The end of October terminates the autumnal season. The rest is winter. During the whole spring season easterly winds prevail; at first interrupted by blasts from other quarters, accompanied with sleet or rain, but, as the season advances, becoming more steady,

words, "offers a strong example of the necessity which the geologist is under of taking nothing on trust, and of concluding nothing from inductions, when the evidence of contact can be obtained."—*Western Islands*, vol. i. p. 143.

* We have as yet no data for ascertaining the temperature of any portion of the Outer Hebrides. It would scarcely interfere with the labours of the clergy there, to pay some little attention to the natural phenomena around them, nor would they be acting more inconsistently with their character in marking the indications of a barometer or thermometer, than in attending to their cows, and superintending the cultivation of their farms. I am not certain that there ever was a thermometer in Harris, excepting an unfortunate one which I carried there in 1820, and which one of the fair natives broke to pieces, with the view of appropriating its envelope as a needle case, before I had made any other use of it than ascertaining the temperature of a few springs, which I found to be as follows:

Springs.	Date.		Water.	Air.
Spring at North Town,	June 2.	2 P. M.	51°	52°
Ditto,	—— 3.	9 A. M.	51	47
Ditto,	Oct. 10.	Noon.	51	48
Mineral well at Big Borg,	June 3.	8 A. M.	48½	47
Ditto,	—— 4.	1 P. M.	48½	—
Ditto,	—— —	Noon.	48½	61
Mineral spring at Drumnancaorach,	—— 3.	Noon.	48	49
Mineral spring, south side of Loch Langavat,	—— 3.	1 P. M.	49	48
Ditto,	—— 7.	1 P. M.	46	53
Spring at Drumaphuinnd,	—— 5.	3 P. M.	49	50.
Tobar-a-chladich, Nisbost,	—— —	Noon.	49	59

and accompanied with dry weather, occasioning much sand-drift. The first part of summer is sometimes fine, but not unfrequently wet, with southerly and westerly winds. There is seldom any thunder at this season; nor does the summer temperature scarcely ever rise so high as to be oppressive. Frequently the wet weather continues with intervals till September, from which period to the middle of October the weather is generally fine. As the winter advances the westerly gales become more boisterous and continued, and, in this season, there is frequently a good deal of thunder. One of the finest thunder blasts I ever met with occurred at Harris in December of 1820, at midnight, during a very hard gale of westerly winds. The lakes seldom freeze in winter; and, although the hills are often tipped with snow, it is seldom that a general covering takes place. After continued westerly and northerly gales, enormous billows roll in from the Atlantic, dashing upon the rocky shores with astonishing violence; I have seen the spray driven over rocks a hundred feet in height, to a great distance inland. Even in summer the spray is sometimes carried inland, so as to injure the vegetation; and I have known a farmer, who had injudiciously planted his potatoes too near the shore, lose his whole crop, in one night, from such a cause. A winter in the Outer Hebrides is dreary in the extreme. Tempests and gloom alternate, with days of sunshine, and sometimes of calm, when the hollow roar of the breakers, occasionally interrupted by the shrill scream of the wandering sea-bird, inspires a melancholy, unfelt during the rage of the tempest. There is not a grander spectacle than that which the great ocean presents at this season, boiling and foaming as far as the eye can reach, rolling its long and widely separated billows into the sounds, and breaking upon the headlands with inconceivable fury, shaking the solid rocks to their foundations; while, along the surface, sweeps the western blast, scattering the broken summits of the waves into spray, and athwart the threatening sky are driven, in confusion, enormous masses of black clouds, charged with electrical matter, and pouring forth rain, sleet and hail. So violent are the winter tempests, that the huts are frequently unthatched, sometimes unroofed; boats have been raised into the air, and shivered to pieces, and cattle carried off their legs. In those sudden blasts, one has sometimes

to fall flat, on hearing it approach, and cling to the ground. But, if there be much gloom, there are also glimpses of sunshine. And he who, from the summit of Clisheim, can view the long range of islands laid out at his feet, sending up their thousand thin streams of white smoke from the kelp-kilns; and, turning toward the east, behold the mountains of Skye, and, beyond them, of the mainland from Knoydart to Cape Wrath, like the unconquerable barrier of some enchanted land, with the smooth waters of the Minch flowing between; or, directing his view to the west, see the magnificent ocean, glowing with the splendour of the setting sun, and the lofty isles of St Kilda rearing their giant heads afar,—can look and not be moved to extasy, is of a more leaden temperament than is commonly to be met with. In the short nights of summer, the sweet and melancholy song of the throstle has scarcely ceased on the hill-side, when the merry carrol of the lark, couched among the soft herbage, commences, and the snipe and curlew sound their shrill notes. To enliven the long nights of winter, the northern heavens are sometimes illumined by the polar lights. At one time, a great arch, of a white and cloudy aspect, stretches from east to west; at another, flashes of pale light emanate from the pole to vanish in the zenith, sometimes a thousand streamlets spread over the starry sky, ever changing with inconceivable rapidity; armies, as it were, are seen encountering in the heavens; and I have been gravely told by the natives, that, after such exhibitions, the moss on the moors has been seen tinged with red from the blood that has fallen during the conflict *. Again, how delightful a midnight walk by moonlight on the lone sea-beach of some secluded isle, the glassy sea sending, from its surface, a long stream of dazzling light, no sound, save the small ripple of the wavelet, or the scream of a sea-mew watching the fry which swarms along the shores. Even in this desolate land there is beauty; and even here might man be happy, did not selfishness mar the bounty of providence †.

* Tufts of Sphagnum obtusifolium on the moors are frequently of a bright red colour, which the natives attribute to the cause mentioned.

† The effects of mirage, as exhibited among the islands, are often extremely striking; but, as they are well known, it is unnecessary to describe them here. I shall only remark, that this phenomenon is best seen the nearer the

Geology.—Gneiss is the predominating rock in Harris. All the inhabited islands consist of it. In the Forest there are numerous beds and irregular masses of hornblende rock, hornblende mixed with black mica, and scaly mica. At Marig, on Loch Seaforth, there is a deposit of hypersthene rock, of considerable extent; and in the island of Scalpay, close to the lighthouse, a bed of serpentine and potstone, with veins of green talc and flexible asbestus. The northern part of the second division is gneiss, the greater part of the middle portion granite, and the southern part chiefly gneiss, with masses of syenite and garnet rock. At the junction of the granite with the gneiss, along the north side of Loch Langavat, there commences between Finsbay and the eastern extremity of that lake, an irregular bed of indurated talc, with talc slate and asbestous actynolite. Close to the eastern extremity of the lake, it forms a considerable eminence named Scaire-ruadh, and, proceeding westwards, appears, at long intervals, in the form of great nodular masses, and terminates in the Dun of Borg, near the west coast. It contains immense quantities of actynolite of several varieties, hornblende, rigid asbestus, and dark-green mica. The varieties of the gneiss are endless. The principal minerals which enter into its constitution are quartz, felspar, hornblende, mica, and garnet. The most beautiful kinds are those which contain garnets, of which fine examples are seen in the Glen of Rodill, in the Corry of Ronaval, at Big Scarista, and in Ben-Capval. In the northern part of the latter mountain, a variety of garnet, much resembling cinnamon-stone, forms a principal ingredient in the rock. The most remarkable geological appearances are those presented by the veins, which are of two kinds, greenstone and granite. Of the former, the finest is a great vein, running from Shelibost, near the sand of Losgentir, to the

observer is to the level of the sea, and in calm weather with sunshine, when a sort of exhalation is expanded over the surface, in which rapid and minute motions are presented, very much resembling the appearance produced when a quantity of alcohol is poured into water. The mirage is common on the sands of the west coast, where it always presents the appearance of water, and, by distorting and amplifying the sand-banks, rocks, sea-birds, and other bodies, produces fairy landscapes, in which lakes, trees, ruins, and fantastic dwellings, are mingled in strange disorder.

east coast. It is about thirty feet thick, and in general rises several feet above the surface, presenting the appearance of an enormous wall, and in some places of the ruins of castles. Unlike most of the others, it is very large grained. Of the granite veins, the largest is that which runs across the face of Ben-Capval, over an extent of a mile and a-half. There are others of the same kind in Ronaval, in Taransay, and in many other places. The ingredients are of large size, and consist of red or white felspar, quartz of various colours, sometimes granular, and mica in large plates *. The simple minerals which I have observed in the country are the following.

Quartz of various colours, grey, white, brown, milky, and pale-rose. Felspar, generally flesh-coloured in the granite veins, and whitish in the gneiss. Moonstone, in granite veins opposite the rock of Stromay. Mica, grey, brown, dark-green, black, in plates of upwards of nine inches, also scaly. Garnet, of numberless varieties, and of all sizes from four inches downwards. Cinnamonstone. Hornblende, in the gneiss, also as hornblende rock, and crystallised. Hypersthene, at Marig. Cominon and asbestous Actynolite. Flexible and rigid asbestus in immense quantities †. Talc, common green. Indurated Talc. Potstone. Limestone. Sahlite and Coccolite in the limestone at Rodill. Beryl, white, opaque, in the granite vein of Ben-Capval. Zeolite, in the trap veins. Calcedony, in small specks in the trap-veins. Clay, of a light green colour, chiefly on the declivities, seldom of great depth, and commonly mixed with fragments of gneiss. Porcelain earth, forming a deposit under peat, as well as the bottom of a lake, between Rodill and Finsbay, and which the inhabitants of the village of Rodill, now depopulated, formerly used for white-washing their huts. Bog-iron-ore, dark-brown, compact, with vesicular cavities, in considerable abundance, in many parts of the Forest, and southern division. Titanitic iron-ore, in granite veins. Iron-pyrites. Zircon, discovered by Mr Nicol; see former Number of this Journal.

Peat and sand form the principal ingredients of the soil of Harris. The upper parts of most of the mountains are covered

* It is remarkable of these veins, that the trap ones generally present distinct lateral surfaces, while the granitic, in all cases that I have examined, pass by a rapid transition into the bounding gneiss rock.

† Dr MacCulloch mentions the occurrence of asbestos at Nishishee (Inissith, pronounced Inishshee), which he conjectures to have been derived from a bed of serpentine. At Inishshee I found neither asbestos nor serpentine; but of the former I have seen enough in the country to load an Indiaman. It occurs in a large perfectly isolated mass in granite in the hills of Little Borg,

with fragments of gneiss, and their lower parts with peat, upon a subsoil of clay or angular gravel. The valleys, where the rock does not occupy the surface, are covered with peat, commonly thin; but, in some places, where the surface is pretty level, from three to eight feet deep. There are no extensive tracts of flat peat. It is not necessary to describe the numerous varieties of this substance that occur in Harris; and I shall only mention that some of them are very little inferior to coal as fuel. In a few places, such as the Glen of Rodill, part of the farm of Strond, and part of Ob, the soil is gravelly, with a mixture of vegetable mould and clay. The sand of the west coast consists entirely of comminuted shells. Fragments of mytili, myæ, venuses, mactræ, and other common shells, are easily distinguishable in it; and the shells of Patella vulgata and Cardium edule occur even to a great distance from the shores, in a scarcely altered state. This calcareous or shelly sand varies considerably in fineness; that near the sea is in general the coarsest. By the attrition which its particles undergo in blowy weather, it is sometimes, and especially in the spring season, reduced to a very fine powder; and from the west side of the island of Berneray, and the east side of Pabbay, may often be seen carried out several miles to sea, in the form of a dense white mist. I have already mentioned the two large flats formed by this sand on the west coast. In other places it is heaped into banks, sometimes upwards of twenty feet in height; and wherever it abounds, it is mixed by drifting with the peat or earthy soil immediately behind it, producing excellent pasture ground

Population.—According to the census of 1821, the population of Harris was 3909. As in most of the other Hebrides, it is entirely maritime, there being scarcely a hut in the country 500 yards distant from the shore. The inhabitants exhibit conside-

in a small eminence on the farm of Middle Borg, in a vein near the houses at Big Borg, in the Dun of Borg; and from thence to the east side of the country, in a dozen different localities, in the irregular deposit, of which Scaire-ruadh forms the most remarkable point. I mention these localities as being all in connection; but it occurs moreover in many others. As to serpentine, I have never seen any in Harris, excepting the bed in the island of Scalpay.

rable diversity in their appearance. In general they are of small stature; those individuals who are considered by them as exceeding the ordinary size, and accordingly designated by the epithet *Mor*, or Big, seldom exceeding 5 feet 10 inches in height. Scarcely any attain the height of 6 feet; and many of the males are not higher than 5 feet 3 or 4 inches. They are in general robust, seldom, however, in any degree corpulent, and as seldom exhibiting the attenuated and pithless frame so common in large, and especially in manufacturing towns. The women are proportionally shorter, and more robust, than the men. There is nothing very peculiar in the Harrisian physiognomy; the cheek-bones are rather prominent, and the nose is invariably short; the space between it and the chin being disproportionately long. The complexion is of all tints. Many individuals are as dark as mulattoes, while others are nearly as fair as Danes. In so far as I have been able to observe, the dark race is superior to the fair in stature and strength.

It is scarcely possible to conceive a constitution more callous to all sorts of vicissitudes and hardships, than that of the Hebridians in general. A native of Harris thinks nothing of labouring in a cold and boisterous spring-day with his spade, up to the ankles in water, and drenched with rain and sleet. Nor is there to be found a race more patient under privation. A small quantity of coarse oatmeal and cold water will suffice to support him under fatigues that would knock up a pampered Englishman or Lowlander. In respect to intellect, they are acute, accurate observers of natural phenomena, quick of apprehension, and fluent in speech. In their moral character, they are at least much superior to the population of most of the lowland parishes. Murder and robbery are never heard of among them; and if petty theft be sometimes practised, it is by no means common. They are of an obliging disposition, hospitable in the highest degree, charitable to their poor. The spirit of independence, however, which characterizes the Englishman, is unknown among them, and, accordingly, their respect for their superiors degenerates into servility. They are, in general, not a little addicted to flattery and scandal. In their quarrels they are profuse in abusive epithets; but it is seldom that they come

to blows, even at their funerals or other merry-makings. They are rather lively than grave, and express their feelings and emotions, whether of joy or of grief, in a more obvious manner than would seem becoming in other parts of the land. Although kind to passing strangers, they dislike those who settle among them.

Secluded, as it were, from the world, and ignorant alike of the affairs of other nations and of their own interests and relations, they have no participation in the political feelings which agitate the other parts of the empire. This seclusion and ignorance may also account in some degree for their extreme attachment to their country. I have yet one concluding trait in their character to mention. Old age has been treated with sympathy and respect by nations even the most savage; here it is rather an object of ridicule and contempt. It is melancholy to think of the last years of the poor peasant of the Hebrides, banished to a miserable hovel, excluded from the society even of his own children,—subjected to privation when nature can least bear it,—without the vigour of body or of mind, the buoyancy of spirit and the elevation of hope that supported him in the days of his youth,—without the complacency which respect and deference are so adapted to excite,—and I am afraid, too often, without the friendly advice and benevolent care of him who ought to prepare his mind for the change which he is soon to make.

Formerly the population consisted of two distinct classes, the tacksmen or great farmers, and the common people. The relations of these classes to each other being generally known, it is unnecessary to say any thing on the subject. At present the class of tacksmen is much reduced, and the system of subsetting land has been done away with. The present race of upper farmers, compared with the former, is degenerate, and there are few among them who can boast of those accomplishments which distinguished their ancestors. "It will perhaps," says Dr Macleod in his report (Stat. Rep. vol. x. p. 367), "excite the wonder of posterity to know, that the whole landed possession of Harris, was, down to the year 1792, excepting four small-tenant farms holding immediately of the proprietor, in the hands of eight gentlemen farmers, on whom all the other inhabitants depend; and that this distribution is so unequally proportioned, that two great farms comprehend more than one half of the es-

tate. The principal tacksmen," he continues, "live here like gentlemen; they are, for the most part, men of liberal education, and polite breeding." As I have just observed, things are different now; and of the resident tacksmen, there assuredly is not one possessed of a liberal education, whatever he may fancy himself to be as to polite breeding.

(*To be continued.*)

On the Discovery of Native Iron in Canaan, Connecticut, North America.

We are informed by Mr William Burrall, in a letter, dated 16th August 1826, that his father was surveying a piece of land on the mountains, about three years since, and by accident noticed a black vein in a quartz rock; he pounded upon it some time with a stone, and with considerable difficulty got out two small pieces, the largest of which is in our possession. He has never been at the place since; and probably no other person has ever discovered it, or knows where it is. It is surrounded by woods one or two miles on every side, and is on the top of a mountain 700 or 800 feet above the common average of the land in the town. Mr Burrall says, there is evidence in that quarter of masses of iron, or its ores, of considerable extent, as his compass was materially affected; but the particular vein from which he obtained the pieces appeared to be of no great extent; and the width of it is the same as that of the piece in our possession, which measures two inches wide, and two thick. It weighs eight ounces.

The following notice of the same facts has been received from Mr C. A. Lee.

"*Native Iron on Canaan Mountain, a mile and a half from the South Meeting-house.*—This is particularly interesting, as it is the first instance in which native iron, not meteoric, has been found in America. It was discovered by Major Burrall of Canaan, while employed in surveying, several years ago. It formed a thin stratum or *plate*, in a mass of mica-slate, which seemed to have been broken from an adjoining ledge. It presents the

usual characters of native iron, and is easily malleable. For some distance around the place where it was found, the needle will not traverse, and a great proportion of the tallest trees have been struck with lightning. Whether these phenomena are connected with the existence of a large mass of native iron, as yet undiscovered, I leave for others to determine; the facts, however, may be relied on."

"*Physical and Chemical Properties of the Native Iron of Canaan,* ascertained in the Laboratory of Yale College, by Mr C. U. Shepard, at the request of the editor.—In its first appearance to the eye, the native iron of Canaan resembles highly crystalline plumbago; being every where invested with a thin coating of this mineral, which completely defends it from oxidation. Its structure is visibly crystalline, separating with considerable readiness into pyramidal masses, and more usually into oblique tetrahedra. This cleavage, however, never takes place without the intervention of thin scales of plumbago. It falls considerably short of meteoric iron in malleability, toughness, and flexibility; as well as in the silvery whiteness of its lustre, which, in part, is no doubt due to the plumbago diffused through it. In hardness and magnetic properties it does not differ perceptibly from pure iron. Its specific gravity varies from 5.95 to 6.72.

"Intermingled with it occasionally is *native steel.* One angular fragment, weighing about eight grains, was perfectly brittle, sufficiently hard to scratch glass, and possessed of the characteristic granular structure, and silvery white colour of steel. With the microscope no scales of plumbago were noticeable in it. Dissolved in dilute nitric acid, it afforded an evident quantity of black, carbonaceous matter, upon the surface of the solution.

"A fragment of the native iron, weighing 100 grains, was dissolved in dilute nitro-muriatic acid. The plumbago attached to it being left behind, was separated, and found to weigh six grains. To the solution was added, in excess, perfectly caustic liquid ammonia, by means of which the iron was thrown down. The ammoniacal solution was then examined for lead, copper, or any other metal which might be present, by adding to it

hydrosulphuret of ammonia. No precipitate, nor change of colour, was produced, though suffered to remain for several days, which leads to the conclusion, that our mineral is unalloyed with any metal. In this respect, therefore, it differs from the native iron of Saxony, in which Klaproth found, lead 6.0, and copper 1.50. The iron being washed and heated, weighed 127 grains; which being in the state of a peroxide, according to Mr Children, indicated 88.90 metallic iron, or, according to Klaproth, 92.21 metallic iron.

"To secure greater accuracy, the process was repeated with 50 grains of the mineral, from which were separated 3.50 grains plumbago The iron was precipitated as before; and after being heated, weighed 63 grains, which, according to Children, indicated 44.10 metallic iron, or by Klaproth's rule 45.90."

"*Remarks by the Editor.*—There can be no question that the native iron above described is a genuine production of the earth, and that it holds no connection with meteoric iron. The mass bears the marks of a true metallic vein, it has smooth sides, and small specks of blue and white quartz are sticking in it. Nickel, constantly found in the meteoric irons, is absent from this specimen; and if it were a question whether native iron be a true production of mines, this discovery decides it."—*Silliman's Journal*, 1827

General Observations in Natural History, made during a Journey among the Blue Mountains in New South Wales. By M. R. P. Lesson.

IN this short itinerary, we only propose to give a summary account of the animal productions which are peculiar to the climate of New South Wales, a country so fertile in interesting species, and so rich in animals still little known. The short stay which we made at Port Jackson, does not permit us to enter into extensive details on this subject, and we can only add some gleanings to what has already been observed by preceding travellers. The English, who have established a splendid colony in this part of the globe, are excellently situated for

exploring the country with complete success, and leaving nothing to be desired with respect to it by the naturalists of Europe. We do not find, however, that they have as yet taken due advantage of their excellent opportunities; and if we except the works of Shaw * and Lewin †, both of considerable merit, no particular work has made known in detail the natural riches of a country still almost unknown, especially in its interior. We have much to hope from Mr Macleay, who has received an appointment there ‡, and we have reason to regret the departure of the last governor, General Brisbane, who did all in his power to facilitate the pursuits of naturalists, and who treated us with a benevolence for which it affords us pleasure to testify our highest gratitude. The investigations, which have had for their object to elucidate the zoology of New Holland, are contained in our classical works and scientific collections; and every body knows the important researches of Messrs Cuvier, Geoffroy St Hilaire, De Blainville, Labillardiere, Peron, Lesueur, Quoy, and Gaimard, in France; of Messrs Banks, White, Phillip, Latham, Knox, Home, Vigors, and Swainson, in England; Blumenbach in Germany; and Temminck in Holland.

In this itinerary we shall follow the order of our encampments, and of our progress across the Blue Mountains. But before proceeding farther, we must make a remark or two regarding the manner in which this barrier has been broken, a barrier rendered famous by what Peron has related of it, and by the attempts which several Englishmen made to surmount it, and especially the celebrated Bass.

The year 1813 was very dry; the springs disappeared, the grass was burnt up, and the cattle perished for want of food. Messrs Lawson, Blaxland, and Wentworth determined to attempt the passage of the Blue Mountains, in search of fresher pastures, in order to repair the disasters of the year. They

* Shaw (George), Zoology of New Holland, Lond. 1794. 8vo.

† The Birds of New South Wales, by John Lewin, 4to. 26 plates. There is also a work by the same author on the Lepidoptera of New South Wales, 1 vol. 4to.

‡ Named this year secretary-general of New South Wales, the most important office next to that of governor.

crossed the Nepean at Emeu-ford, and ascended the first plain of the Blue Mountains with ease. They then got embarrassed among numerous detours, and were on the point of renouncing their project. But at length their obstinate perseverance was crowned with success, and after having descended York Mountain, they discovered a rich and fertile country, and returned to Port-Jackson, to announce this important discovery.

I have always been astonished at the difficulties which those who first attempted to cross these mountains have said they had undergone; for their height, at the highest summit, is not more than about 2500 feet, and the two ranges which they form are connected by undulations of no great importance, and could scarcely present any obstacle at York Mountain for descending into *Clyde Valley*. We must suppose that all those who tried the enterprise in the earlier times of the colony, had coasted the rugged and steep sides of the Prince Regent's Glen, which is a deep valley, the vertical walls of which must naturally have presented insurmountable obstacles, although at a short distance it was easy to pass over the sloping declivities which connect the various divisions of the first range of the Blue Mountains.

Having provided ourselves with a cart and guides, M. Durville and I set out on the 29th January 1824. I shall not describe Sydney, Paramatta, or the farm of Emeu Plains, which is bounded by the Nepean, and now abundantly covered by the cereal productions of Europe. This rich and beautiful plain is situated at the foot of the Blue Mountains, twenty miles distant from Sydney Cove. The rock is uniformly ferruginous sandstone, excepting the Prospect Hill, where the curious phenomenon is observed of a high eminence, consisting entirely of *dolerite*, the foot of which is enveloped in sandstone, which is everywhere uniformly of the same nature. In the fresh and running waters of the Nepean, I found a very small *Cyclas*, together with a species of *Unio*. A small *Teal*, allied to, or perhaps even identical with, the *Soucronette*, lives in flocks upon this river, which is no longer inhabited by the Ornithorynchi, or at least in such small number, that it is very rare to have any in this locality. To supply this want, however, the yellow-crested Cockatoos, (*Psittacus cristatus* of Latham), made the wood resound with

their cries, perched on the trees, in the holes or chinks of which they nestle.

In this place I had to regret my not being able to kill the singular bird, commonly named at Sydney the *Coachman's Whip*, because its cry, which I have often heard, resembles exactly the smack of a whip. Is this bird a Philedon, and has it been described? The purple Choucari, the *Satin-bird* (Graculus), equally prefers the high Casuarinae, which border the Nepean, at its exit from the Blue Mountains.

On the 31st we began to ascend the first range. The road, as far as *Springwood*, is a gentle acclivity, and the whole face of the mountains and the ravines, by which they are divided, is covered with forests of *Eucalypti* and *Casuarinae*. The *Mimosa taxifolia*, a new species of Cunningham's, was in flower, and exhaled the most agreeable odour among bushes of *Lambertia speciosa* and *Protea*. It is here that the Menura (*Menura magnifica*; *M. Novæ Hollandiæ* of Latham), is chiefly found, the tail of which, remarkable for its great beauty, presents, in the solitudes of Australia, an exact pattern of the harmonious lyre of the Greeks. This bird, to which the name of *Wood Pheasant* is given by the English of Port Jackson, frequents the rocky and retired districts; it comes forth in the evening and morning, and remains quiet during the day upon the tree, where it is perched. It is becoming every day rarer, and I only saw two skins that had been preserved by Mr Lawson, during the whole period of my stay in New South Wales.

We arrived in the evening at the Swamp, an extensive marsh, where we put up our tent. We observed in this place a great number of crows (*Corvus corone*, Lin.), the species of which does not seem to differ in any respect from that of Europe: a small goatsucker, with very prettily marked plumage (*Caprimulgus Novæ Hollandiæ*), and the banded skink (*Scincus nigro-luteus* of Quoy and Gaimard*). The heat during the day was very great, and a thick fog spread itself over the mountains, on the approach of night, which was very cold. The change of temperature is extremely rapid in these countries.

On the 1st of February we crossed the chain, which at its most elevated point is named *King's Table Land*. Its height is

* The *Lacerta pictura* of White is very rare here.

2727 English feet *. The sandstone is nearly exposed in all parts; the vegetation is patched, and consists of some species of *Casuarinæ* and *Eucalypti*, and it is here that the pretty *Patersonia glabruta* of Brown grows in the greatest abundance.

Not far from King's Table we discovered a rich valley, inclosed by vertical walls, 676 English feet high, formed of regular strata of sandstone. It was the Prince Regent's Glen. From the place, named Pitt's Amphitheatre, the view extends to a great distance over the various undulations of the chain of the Blue Mountains. Torrents of smoke rose from various parts of the woods, which, from the negligence of the savages, are very often set on fire.

On our way to Blackheath, I found in the middle of the heath, in a state of complete torpor, the *Black* and *Yellow Skink* of Port Jackson, figured in the geological atlas of Messrs Quoy and Gaimard, in Freycinet's Voyage. What is remarkable is, that I found another individual in the same state some days afterwards; and that those which the naturalists of the Uranie brought with them, were collected under similar circumstances.

York Mountain, or Cox's Pass, is elevated 3292 feet above the level of the sea; and the path which it was necessary to make upon the steep side of this mountain, to descend into the charming valley of Clyde, is so rough, that although it has been made to describe several turnings with great labour, it is still a difficult point, and is frequently the occasion of accidents; and carriages somewhat heavily loaded can only be got up the acclivity by means of hard straining. At York Mountain, sixty-two miles distant from Sydney, the sandstone formation, which is often ferruginous, containing hydrate of iron, which gives it its colour, together with iron glance, disseminated in shining scales, entirely ceases, and then commences the primitive formation, which extends to Bathurst, consisting of quartziferous, granitic and syenitic rocks, which extends to Bathurst. These rocks alternate in the bed of Fish River, with a blackish quartziferous petrosiliceous porphyry. The tops of the mountains near Cone's River, are covered with a common strained pegmatite †.

* According to Mr Oxley's map.

† All these specimens have been sent to the Museum, and examined by M. Cordier.

It is in York Mountain that the *Echidna Hystrix* of Cuvier chiefly lives, which the English rear in a state of domesticity, for the purpose of selling them at a very high rate to collectors. This animal, which in appearance approaches the hedgehog, has accordingly obtained that name among the colonists of New South Wales. It burrows, and does not willingly come out in dry weather; it is therefore difficult to procure it during several months of the year. According to the accounts of it which I have received from the convicts who inhabit York Mountain, it lives upon insects and legumes, and chiefly on ants, which it gathers with its tongue, after the manner of the ant-eaters. It emits a small grunting sound when disturbed, and its manners, in a state of liberty, are but little known. I could obtain no further intelligence respecting it from the inhabitants of the country. An *Echidna*, which I had procured, and which my colleague, M. Garnot, endeavoured to carry to Europe, gave him an opportunity of publishing an interesting note regarding the manners of this animal in a state of captivity *. This place, like all the neighbourhood of Port Jackson, and especially the country about Botany Bay, is infested with the black snake, the most formidable reptile of this country, and that whose poison acts with most celerity. A great number of serious accidents are mentioned as having been caused by the bite of this *Acanthophis*, which is distinguished by the shining black of the upper part of its body, and the agreeable rose-colour of the under part.

We crossed Cox's River, formed by the junction of two small brooks, upon fallen rocks of a very beautiful granite. This river flows from east to west. I procured here the large and small flying phalangers, (*Petaurista taguanoides* and *P. sciurea* of Desmarest). At York's Bridge we killed several species of philedons: they live in flocks in the large encalyptuses. We procured an undescribed species, as well as the *Spotted Philedon (Certhia Novæ-Hollandiæ*, Lath.) the *white fronted Philedon*, the *Speckled Philedon*, and the *Black-cap*. (*Certhia atricapilla*, Lath.)

On the third of February we reached Fish River, where we encamped with the intention of killing ornithorynchuses. The

* See the Annales des Sciences Naturelles, for December 1825.

long drought had very much diminished the depth of its waters. It was fordable in most places. The *Ornithorynchi*, which are called *Water-Moles* by the colonists, and *Moufllengong* by the natives, inhabit the banks of this river in considerable abundance, while they have become very rare on those of the Nepean. They are still pretty numerous at the proper season in Campbell and Macquarrie Rivers, and at Newcastle. The specific name of *paradoxus* has been given to this singular animal *, of which Shaw has made his genus *Platypus*, and Blumenbach the genus *Ornithorynchus*. Its extraordinary forms seem to sanction this name. Dr Knox, when he announced to the Wernerian Society of Edinburgh, his beautiful discovery of the crural gland, which communicates by a canal with the spur with which the hind feet are armed, was virulently attacked by a physician of Port Jackson, in the Sydney Gazette. The Australian doctor denied the existence of the gland and its duct, and supported his opinion by the consideration that there was no proof that a dangerous wound had ever been inflicted in the country. He asserted, that these spurs, of which the female individuals never have any, are intended for the purpose of assisting the males to lay hold of the females, and to keep them immoveable during the act of generation. Subsequent observations have reduced these assertions to their true value. The colour of the fur of the ornithorynchus is ordinarily dark brown. Some varieties of age or sex that have been considered as species, are of a reddish colour. Mr Murdoch, the superintendant of the farm of Emeu Plains, assured me that he had found ornithorynchus's eggs, and that they were of the size of those of a domestic fowl.

After having waited for several hours in a state of perfect immobility, to see if any of these animals would make their appearance, I left the banks of Fish River, and the small rocks on a level with the water, to which they resort on issuing from their holes. I was afterwards informed, that, at this season of the year (January and February), the ornithorynchus remains close in its burrow, and only appears at the time of the great

* See Peron, Voyage aux Terres Australes; Desmarest's Mammifères; Vanderhoeven, Nov. Act. Acad. Cæs. Leop. Carol. t. xi. Knox, in the Memoirs of the Wernerian Society, and the Annales des Sciences Naturelles; Sir Everard Home; Blainville, &c. &c.

rains, which, by causing the waters of the rivers which it inhabits to swell, drive it out, and force it to keep upon the surface of the water, and among the rushes, which edge the banks. Dr Jamieson, who lives at Regent Villa, and who is busy collecting the productions of New South Wales, has in his possession a considerable number of ornithorynchuses preserved in spirits of wine. He had the politeness to promise my companion and myself some of them; but he has without doubt been unable to fulfil his promise. It is difficult at present to procure this animal; and the skins which one gets in the country, from being ill prepared, and not covered with preservative substances, easily spoil. On the eucalyptuses of the neighbourhood of Fish River, I observed several large *King's-Fishers* (*Dacelo fulvus*), which emitted a deafening noise, that was still more increased by the echoes. Their cry is sharp and prolonged; and these birds are stupid and fearless.

Although the edges of Fish River are pretty agreeable, they yet present that monotony which is universally characteristic of the vegetation of these countries. Besides, about a score of species of *Eucalyptus*, the appearance of which is very much alike, there are only to be seen, and with no variety, *Mimosæ*, *Metrosideroses*, *Proteæ*, *Casuarina*, and a very few European genera along the edge of the waters. Hence the forests of Australasia have a sad and lugubrious aspect. In crossing the Blue Mountains, one cannot fail to remark the uniformity which nature has given to the leaves. Their form, excepting perhaps that of some mimosæ with bipinnated foliaceous expansions, is generally simple, and they are more or less dry, stiff and smooth. She would seem to have accommodated them to the dryness of the soil, by giving them an oblique direction, for the purpose of presenting the greatest possible surface to the air, which must furnish their principal nutriment. New Holland alone presents the singular phenomenon of entire leaves or foliaceous petioles in trees which are every where else remarked for the extraordinary elegance of their divided foliage. Another remark, which is not new, it is true, is, that the Blue Mountains, as well as the whole surface of New Holland, are entirely destitute of alimentary fruits, excepting the *Sorose*, a bramble allied to *Rubus fruticosus*, and a small berry, of which the Europeans make a

very good preserve, and which is produced by the *Leptomeria Billardieri* of Brown; all the fruits of this country are woody and coriaceous *. For this reason, the natives have been forced to inhabit the banks of the river, and to follow their course in wandering tribes, according as the resources of the chase or fishing become exhausted. Whence arises that absence of art, that profound barbarism, in which the black race of this country is immersed, which drags on a miserable existence, approaching that of the brutes. How different from the half-civilized state of the happy islanders of the *Oceanic* race, whose soil, rich and fertile in nutritious fruits, is sufficient to ensure the existence of tribes, which do not require to provide for their daily subsistence by such fatigues.

The eucalyptuses which cover the eminence, before arriving at Sidmouth Valley, present this peculiarity, that their bark is white, satiny, and torn into long straps, which hang from the branches, and make a peculiar noise. They afforded a refuge to a great number of small green parrots with red heads, and of the size of a sparrow, (*Psittacus pusillus*, Lath.), which cried all together at sun rise. On crossing Fish River, at a distance of ten miles from the farm of Renneville, we found in the waters, which ran over granite pebbles, a considerable number of insects of the genus *Gyrinus*, and a species of *leech*, the body of which is brown, and marked with two broad, longitudinal, yellow bands. This animal manifested a great avidity for blood.

Presently there opened upon us Bathurst Plain to the right, and Macquarrie Plain to the left. The former of these, in the middle of which is situated the establishment which bears the name of the present minister for the Colonial Department in England, is of great extent, and entirely clear of wood. It is covered with *Gnaphalium* and *Xeranthemum bracteatum*. Clouds of *Crickets*, the elytra of which produce a peculiar clatter, flew off at every step. The *Coturnix australis* of Temminck is very common here; its white and delicate but flavourless flesh is highly esteemed. We saw several species of *Hawks* (Auturs-set Eperviers), but did not kill any of them. We remained

* M. D'Urville, equally distinguished as an able officer and naturalist, has elicited general conclusions of great interest with respect to this subject.

at Bathurst two days. Mr Morinet, who commanded there, received us with urbanity, and afforded us all the assistance in his power. Bathurst Plain is watered by Macquarrie River, which is the same as Fish River. Its height above the level of the sea is 1970 English feet. It contains about 6000 acres of good arable or meadow ground, which allows a large stock of cattle to be reared. It is here in particular that the Spanish breed of sheep has been propagated, which affords a beautiful wool, but which has never to this day been transported to England without being damaged. A hundred miles from Bathurst, in the interior, Wellington Valley has been cleared, and here a post of incorrigible convicts has been established. In the south-west, far beyond Mount *Molle*, common limestone has been discovered, a mineral substance of which New South Wales seems destitute, and of which the English are in the greatest need for the building of their houses, as the shores do not afford enough of shells for that purpose. This article was ardently sought for, and it was not without the greatest satisfaction that the cave was discovered which lies to the north of Bathurst, at the distance of sixteen miles, of which the roof is lined with thick stalactites of a calcareous alabaster, furnishing an excellent lime. Ten miles from this establishment, at Pine-ridge, there is a forest entirely composed of cedars, (*Callitris spiralis* of Brown), the wood of which is excellent for building.

Macquarrie River, which is neither deep nor broad, has its banks covered with European plants. There are found here potamogetons, aquatic *Ranunculi*, the *Lythrum Salicaria*, the *Samolus*, the *Verbena officinalis*, the *Polygonum aviculare*, or a species closely allied to it, &c. I found fishes in this river which form two new genera; the first species, named *Gryptes Brisbanii* of the family of perches, and the second named *Macquarria Australasiæ* *. They attain a large size, and are much esteemed as food. The *Gryptes* is often three feet long, and nearly sixty pounds weight. An *Emys* (the *Testudo longicol-*

* So named by MM. Cuvier and Valenciennes, in the catalogue of the Collections which we brought to the Museum. I have proposed the name of *Gryptes Brisbanii* for the first, in honour of the Governor of New South Wales, who received us with the greatest kindness.

lis of Shaw), entirely black, with a very flat shell, and a long neck, is also found in Macquarrie River. This species does not draw its head under the carapace, but lodges it upon one of the sides, between that part and the plastern, which thus afford it protection. The pretty *Rainette dorée* of Peron, a *Physa* (*P. australis*), and a *Lymnæa* with a very brittle-shell, enriched our collections.

On the banks of this river I observed a species of *Lapwing* which was extremely wild. It is called the *Spur-winged Plover* by the English, and is probably the *Charadrius pectoralis* of Cuvier. The colonists know a reptile with a very slender body under the name of *Thread-Snake*, the bite of which is followed by almost instant death; and I have been assured that horses will not live beyond fifteen or twenty minutes after being bitten by it. I am not aware that this serpent is mentioned by any author, and it would be interesting to confirm its existence.

We have not thought it necessary to give any particular account of the general aspect of the country. Details of this nature would be out of place here; and we prefer briefly mentioning some of the geological objects which we had an opportunity of seeing during our short stay at Sydney. We shall, in the first place, make a few remarks on the race of the human species which inhabits this country. To judge by his external appearance and intellect, the native of New South Wales would seem to have been degraded from the true rank of man, and to approach the nature of the brute. Whatever may be the opinions of writers with regard to their history, and the numerous differences by which they have supposed them to be separated from other tribes of the black race, after having properly considered our data, and viewed them in every light, we here state the result of our reflections, without attaching any other importance to it.

The *Australian Negro* race, which is peculiar to New South Wales, does not appear to us to differ in any thing essential from the *Oceanic Negro* race *, of which the Papous alone form another somewhat distinct branch. It presents the most perfect similarity of form and external characters to the inhabitants of New Britain, New Ireland, and very probably to those of New

* The melanitic species, Homo melanianus of M. Bory de St Vincent, Art. *Homme*, in the Dict. Class. d'Hist. Nat.

Caledonia. Their hair is woolly, thick, and arranged in hanging locks; their size is variable, but in general moderate, their average height being five feet four inches. Their cheek-bones are prominent, the nose broad and flat, the mouth large, the lips thick; their extremities, although slender in the greater number of cases, are often regularly proportioned. Separated into scattered tribes, without mutual communication, and wandering about in search of a precarious subsistence, each tribe has created a language of its own, or has been influenced by its local position in the developement of its industry, which is always very limited. The poverty of the soil, and the rigour of the climate, must have exerted an influence upon the race, and deteriorated it; and it is from this source that the slight differences arise, which seem to separate it from the African negro race, with which, however, an attentive examination shews it to be identical. One may conceive the influence which, in the course of time, a country must have, which produces no eatable fruit: the inhabitants must have betaken themselves to hunting and fishing, and become nomadic; they would, therefore, have regarded as useless the formation of permanent villages, and must have confined themselves to temporary places of shelter. They would also have chosen the most indispensable and the most simple implements; they would have constructed their canoes of eucalyptus bark, tied at the two extremities,—or made use of logs, in the form of rafts, to go into the bays and creeks. The negro race, besides, no where shews itself remarkable for its intellect, and every thing announces it to be stationary in its ideas. It has characters which are peculiar to itself, in whatever part its branches are met with. These characters are, the divergence of language of each particular tribe; their common taste for raising conical eminences upon the skin, which is found to prevail as well in Congo, Madagascar, and New Guinea, as in all the parts of New Holland,—and never in the yellow Oceanic race; a peculiar and general custom of marking the face with red and white powders in broad streaks, or of covering the hair with ochre; the habit of not concealing the organs of generation *; that of passing a stick through the septum of the nose; &c. These essential characters are in opposition to those of the

* In all those which have not had any long continued communication with Europeans.

two races of the Oceanic Isles, which we designate by the names of the *Oceanic* and *Mongolian* branches. We shall unfold our ideas on this subject more particularly in a separate essay. In the mean time, it is probable that the negroes of New Holland have extended into the Australian Continent by New Guinea and the eastern islands, and that their migration has been made from the coast of Africa by the great island of Madagascar, which had itself, at a later period, received men of other races. Be this as it may, the number of inhabitants of the county of Cumberland is rapidly diminishing;—and these stupid savages, insensible to all that has been tried for their improvement, have only derived from the Europeans vicious habits, which hasten their destruction, such as an inordinate taste for spirits. Syphilis and smallpox have also at length committed their ravages among them. If the number of native inhabitants is diminishing, that of the indigenous animals is also decreasing in a remarkable manner, and the period is not far distant when all the civilized parts will be destitute of kangaroos, ornithorynchuses, &c. Already the emeu (*Casuarius australis*, Shaw) no longer inhabits the plain called by its name, and which it formerly filled. This enormous gallinaceous bird has fled beyond the Blue Mountains, or beyond the limits of cow pasture. The great kangaroo (*Kangurus labiatus*, Geoffr.) is now only seen in a state of domestication. I observed several of them feeding at large in the west park of Rose Hill, at Paramatta, raising themselves upon their hind feet, to observe what was going on around them, and flying off, when disturbed, by long bounds, lighting, at the same time, upon their short fore feet. This animal, the hard and coriaceous flesh of which is in little estimation, as it is only the hind quarters that are employed for making ordinary soups, is tamed with extreme facility. One was shewn me at Port Jackson, which had been brought up by a soldier of the garrison, and which punctually obeyed the orders of its master. It was a great adept at boxing. This kangaroo shewed a great degree of courage, did not hesitate to attack a dog, and made use of its hind legs or tail for striking those whom it wished to fight, by throwing itself upon them with a sudden and very high bound. With its master it betook itself to sport, and played only with its two fore feet, without seeking to injure him.

Analyses made in Colombo of Ceylonese Varieties of Ironstone and Limestone. By George Middleton, Esq. Apothecary to the Forces. (Communicated by Sir James M'Grigor.)

1. *Reniform, or Kidney-shaped, Brown Clay Ironstone.*—It occurs massive and globular: sometimes these are hollow, (a hollow globular ball, weighing upwards of 21 lb. is in the Museum at Colombo), surface sometimes marked with impressed forms. Fracture conchoidal; lustre semi-metallic; adheres slightly to the tongue; streak pale-brown. Sp. gr. = 3.793, of a specimen from Matelle, and forwarded by Dr Knox for the museum; 4.06 of a specimen from the eastern part of the island. The constituent parts, after two careful analyses, are as follows:—Silica, 10; alumina, 3; lime, 22.5; magnesia, 8.5; oxide of iron, 50; water, 4; loss, 2. = 100.

2. *Granular Foliated Limestone.*—Is white and translucent. Sp. gr. = 2.853; constituent parts, lime, 50; carbonic acid, 42; silica, 2; magnesia, 2; water, 2; loss, 2. = 100. It is quarried at Kandy, and employed for building purposes.

3. *Common Compact Limestone.*—Its colour is greyish white. Sp. gr. = 2.578 to 2.6; constituent parts; lime, 52; carbonic acid, 42; magnesia, 1.5; water, 2.5; Loss, 2. = 100. This limestone was brought from Poælor Cavern, near Jaffna, and was part of a collection of minerals sent by Governor Sir E. Barnes to the Museum at Colombo.

We have much pleasure in communicating the preceding analyses to our readers, as they are probably among the first regular analyses of minerals hitherto made in India. We feel confident that Dr Collier, President of the Colombo Museum, to whom Mr Middleton's communication was addressed, who is an intelligent naturalist, and active medical officer, will continue to encourage the taste for natural history and chemical mineralogy in the East.

Letter from Professor Leslie to the Editor on Mr Ritchie's Experiments on Heat, and New Photometer.

My Dear Sir,

Having long projected the publication of a complete Treatise on the Theory and Application of Heat, I have generally overlooked such statements as have gone forth tending to limit, modify, or contradict the principles I had already established, being convinced that the precise and decisive experiments which I shall produce, must dispel every shadow of doubt. My anxiety to advance nothing except what was ascertained by the most scrupulous accuracy, has hitherto retarded the appearance of that work; but I purpose, without further delay, to perform the task thus imposed.

In the mean time, I may stop to notice a circumstance which has been sedulously turned against the doctrines which I had propounded. If a red-hot ball be held behind a glass screen, in front of a metallic reflector, a considerable impression of heat is concentrated at the focus; from which it has been hastily concluded, that the calorific *rays* emitted from the ball (I borrow the usual language, though it involves an assumption) pass freely through the glass. But the fact is readily explained, from the established principle, that the screen becoming much heated, soon acts upon the reflector by its own *radiation*. Mr Ritchie, Rector of the Academy at Tain, has, in a paper printed in the first part of the Philosophical Transactions for the present year, endeavoured to oppose this explication by some other experiments. Suspending the hot-ball behind a very thin disc of glass, he found a delicate thermometer placed before it to be sensibly affected, though he kept blowing against the disc with a bellows. Now, here lies the fallacy of the experiment; for the current would certainly not make the screen *colder* than the air of the room, as Mr Ritchie supposes, but only prevent it from acquiring so high a temperature as in a still atmosphere. I have elsewhere shewn, that a wind of eight miles an hour only doubles the dissipation of heat from the surface of a body. The continual accumulation from the ball would therefore still enable the disc to *radiate* profusely.

It would be unnecessary to follow the rest of the experiments brought forward by Mr Ritchie, which seem neither happily devised, nor capable of much accuracy.

But a very simple and unexceptionable experiment will set the question at rest. I had a differential thermometer, with parallel branches, constructed of rather large dimensions, one of the balls blown as thin as possible, and the other extremely thick, perhaps the fifteenth part of an inch in thickness. Into the cavity of this ball, sulphuric acid, tinged with carmine, was introduced, sufficient to fill both branches; and the tubes being united, and properly bent, the liquid was adjusted to stand about the middle of the stem, under the thin ball. On placing the instrument near a clear strong fire, the thin ball being more quickly affected, the liquid sank rapidly in the stem, but again rose gradually, and in the space of about ten minutes recovered its station. There it remained, but with a slight fluctuation, owing to some occasional variation in the strength of the fire, or to the fluctuation in the air of the room. On withdrawing this differential thermometer again, the liquid mounted swiftly into the thin ball, but again subsided gradually to its stationary point.

Since both balls, then, were placed in exactly similar circumstances, it follows, that they were equally affected by the afflux of heat, and that no portion of this heat had been transmitted through either of them.

When this differential thermometer was employed as a photometer, it indicated a different effect. Placed in the inside of a room, but close to a south window at noon, the liquor always mounted several degrees, a sensible portion of the light of the sun being absorbed by the thick ball, while it passed without interruption through the thin ball.

I have only to add, that the instrument which Mr Ritchie proposes in the same volume, as a new and peculiarly delicate photometer, is only one of the various modifications of the differential thermometer, which in my earlier experiments I tried for measuring small quantities of light, but which I soon laid aside, on finding its performance to be quite irregular and uncertain.

It is not difficult, indeed, to contrive that an instrument shall have a wide range: but the obstruction to its motion is hence increased, and its power of action is yet proportionally diminished. Accordingly, the simple barometer is esteemed now by far the most accurate; while those barometers of a complex construction, but with large divisions, have deservedly fallen into disrepute.

QUEEN STREET,
10*th Dec.* 1827.

Description of several New or Rare Plants which have flowered in the Royal Botanic Garden, Edinburgh, during the last three months. Communicated by Dr GRAHAM.

10*th December* 1827.

Buddleia madagascarensis.

Lamarck, Encyclop. Method. vol. i. p. 513.—Tableau Encyc. et Method. vol. i. p. 291. t. 69. fig. 3.

B. *madagascarensis;* ramis sub-tetragonis, tomentosis: foliis integerrimis, ovato-lanceolatis, petiolatis, supra nudiusculis, venoso-rugosis, subtus albido-tomentosis; paniculis terminalibus, pedicellis sub-trifloris.

DESCRIPTION.—*Shrub* erect, with long, slender, diffused branches; *bark* pale brown. Younger branches, petioles, back of the leaves, peduncles, pedicels, calyx, and even the outside of the corolla, though this in a smaller degree, covered with dense, white, soft tomentum, which often becomes partially brown. *Leaves* decussating, petioled, ovato-lanceolate or slightly cordate at the base, acuminate, soft, on the upper side dull sap-green, and sprinkled rather sparingly, especially on the young leaves, with white tomentum, slightly wrinkled, reticulated, middle rib and the veins prominent below, channelled above. *Panicle* handsome, (7 inches long from its first branch to the apex,) terminal, erect, bracteate, with two long opposite branches at the base, subdivided like the leading stalk. *Pedicels* like little corymbs, generally supporting three flowers, though often only one near the apex, and sometimes four below. Lower *bracteæ* below the branches at the base of the panicle, resembling small leaves, the others subulate, one below each pedicel, and nearly as long as it, smaller upwards, similar ones at the sides of the lateral flowers. *Calyx* small, (scarcely one-eighth of an inch long,) ovate, 4-toothed. *Corolla, tube* (three-eighths of an inch long), cylindrical, white, slightly hairy within; *limb* 4-cleft, perfectly naked above, segments nearly half the length of the limb, blunt, linear, spreading and yellow when first expanded, afterwards reflexed, revolute in their edges, and deep uniform orange colour, faintly and not agreeably perfumed. *Anthers* 4, sessile in the throat of the corolla, linear, pollen whitish. *Germen* round, greenish, and with the filiform, colourless style somewhat hairy; *stigma* green, oblong, bilobular, subexserted.

Our specimens of this very handsome species were several years ago sent to us, with a liberality by which I often profit, and which I am always happy to acknowledge, from the Royal Botanic Institution of Glasgow, and introduced into it, I believe, direct from India. The tomentum, by which it is so generally covered, is pure white, and could only have

been described as rusty, from the characters formerly given having been taken from dried specimens. Even these, however, if they have been carefully prepared, remain white. To the same cause I would attribute the sparing tomentum on the upper surface of the leaves having been overlooked, and the slight difference in the form of the limb of the corolla in Vahl's description (Symbol. Botan. Pars iii. p. 14.), and in Lamarck's figure, from that which I have observed.

Cassia opaca.

C. *opaca;* calycis foliolis obtusis, bracteolis solitariis infra pedicellos, antheris biporosis, glabris; foliis 5–6 jugis, foliolis oblongo-ovatis, ciliatis, nitidis, glandula acuta, pedicellata, inter 1–3 paria inferiora; stipulis ovatis, magnis, erectis, deciduis; racemis axillaribus, pedicellis patentibus.

Description.—*Shrub,* erect. *Branches* scattered, and slightly flexuose, green, and somewhat pubescent when young; *bark* on stem and older branches brown. *Leaves* scattered, spreading or divaricated, leafets in 5 or 6 pairs, oblong-ovate, dark green above, pale below, slightly revolute and ciliated on the margin, every where else smooth and shining. *Petiole* swollen, but having no gland, at its base, a small pointed stipitate gland between one, two, or three of the lowest pairs of leafets. *Stipulæ* large, ovate, erect, and embracing the axil of the leaf, deciduous. *Racemes* axillary, collected towards the extremities of the shoots, erect, half the length of the leaves; *peduncle* without flowers for a considerable distance above its origin, pubescent; *pedicels* pubescent, long, straight, spreading nearly at right angles to the peduncle. *Flowers* looking downwards, handsome, every part except the receptacle, anthers, and germen, of orange-yellow colour; *receptacle* yellowish-green, and large. *Calyx* segments smooth, blunt, of the same colour as the corolla, concave, two outer phylla smaller. *Corolla;* petals clawed, three upper subrotund, notched, undulated, 3-nerved, the lateral nerves branched from their base, and reticulated towards the edge of the petal, central petal the largest, two lower boat-shaped, blunt, without notch or undulations, veins indistinct. *Stamens* very unequal. *Anthers* large, dark brown, smooth, opening by two pores at the extremity. *Pistil* bent down; *germen* green, curved upwards, compressed, many-seeded, having on its surface a few adpressed hairs.

This is a very handsome species, the orange coloured flowers contrasting very prettily with the opaque deep green shining foliage. We received a plant from Raith this season, it having been raised by Mr Ferguson's gardener from South American seeds, communicated by Professor Leslie in 1825.

Leonotis nepetifolia.

L. *nepetifolia;* "foliis cordatis, acutis, inciso-crenatis; calycibus aristatis, octo dentatis, dente supremo maximo, caule herbaceo."—*Bot. Reg.* f. 281.

Description.—Annual. *Stems* herbaceous, erect, green, simple, but with the rudiments of branches in the axils of the leaves, tetragonous, angles very obtuse, sides deeply channelled. *Leaves* bright green, petioled, decussating, spreading, cordate, slightly decurrent along the petioles, deeply serrato-crenate, reticulato-veined, soft, inodorous, covered with fine short and soft pubescence on both sides, veins and their reticulations prominent below, slightly channelled above; *petioles* as long as the leaves, and spreading at right angles to the stem. *Spike* terminal. *Flowers* nearly sessile, in dense, nearly globular, distant whorls, the upper flowers in each expanding first. *Bracteæ* numerous, surrounding the base of the whorl, and nearly hid by it, reflected, keeled, linear, mucronate. *Calyx* curved, subventricose and cucullate, enlarging after the corolla falls, 10-nerved, bilabiate; the upper lip 3-nerved, tapering into one long, straight tooth; the lower lip about half the length of the upper, 3-nerved, and divided into three teeth, spreading nearly at right angles to the tube; throat

with two teeth on each side nearly as long as those of the lower lip, at first spreading, but as the corolla fades, becoming erect, and finally, with the sides of the calyx, advancing so as to contract its throat; all the teeth terminated by hard bristles, whole calyx slightly pubescent on the outside. *Corolla* bilabiate; lower lip short, 3-lobed, withering almost immediately after expansion; upper lip elongated, equal in length to the tube, nearly straight, but slightly arched at its extremity, and 2-toothed, the whole of the corolla except the lower lip and base of the tube, which are smooth, thickly covered with red shaggy hairs, diminishing from the apex of the upper lip downwards. *Stamens* 4, didynamous, rather longer than the upper lip, and hanging loosely; *filaments* arising from the throat of the corolla, subulate, nearly colourless, slightly pubescent; *anthers* crescent-shaped, pale yellow, attached by their backs to the filaments, smooth. *Germen* elongated, and truncated; *style* filiform, nearly as long as the stamens; *stigma* cleft, one of the segments very small.

The figure in the Botanical Register is very good, and the description generally correct, though both were made from a dried specimen. There is a wide range over which it appears that this species is found native. It is certainly the same as the East Indian plant, as is remarked in the Botanical Register. From the statement in the same work, there is reason to believe that it grows in the neighbourhood of the Congo. In the Herbarium of this University, there is an indigenous specimen from Dominica, communicated, along with a valuable collection, by my friend Staff-Surgeon Lyons; and our plants in the Botanic Garden were raised from seeds, collected by Dr Gillies, in South America, and received through Patrick Neill, Esq. in May last. They have been kept in the stove.

Loasa patula.

L. *patula*; capsula contorta, quinque loculari; calyce marcescente.

Description.—*Root* branching, fibrous. *Stems* herbaceous, numerous, spreading wide, ascending, branched, 4-sided, pale, succulent, semipellucid, streaked with deep green. *Leaves* opposite, decussating, petioled, spreading, 3-lobed, the middle lobe by much the longest, lobes doubly incised, each with a strong branching middle rib; petioles channelled, and stem clasping. *Peduncles* axillary, erect, tapering, round, longer than the leaves. *Bracteæ*, 2 at the top of the peduncle, small, subulate. *Flowers* nodding. *Calyx* of 5 subulate segments, marcescent. *Corolla* 5-petaled; petals white, spreading at right angles to the axis of the flower, cucullate, compressed, clawed, with one, sometimes two teeth, on each edge, at the lower part of the limb, and one at the extremity. *Stamens* numerous, inserted into the receptacle, inclosed by the petals, till the pollen is ripe, when they become erect, and advance to the centre of the flower; *filaments* reaching half-way up the hollow of the petals, filiform, colourless, united into five bundles at the base; *anthers* short, bilocular, bursting at the side, greenish-yellow; *pollen* white. *Germen* inferior, obovate, twisted, green, quinquilocular, seeds numerous, and attached to the dissepiments: *style* straight, cylindrical, pointed at its extremity, at first shorter than the nectaries, afterwards nearly twice as long; *stigma* very minute; *nectaries* ten, slender, flattened, curved, half the length of the filaments, and included in pairs in five sheaths, which are erect in the centre of the flower around the style, opening longitudinally on their inner side, yellow, with two reddish-orange bands passing across them near their apex, and two terminal oblong spots: the first band consists of short broad streaks, arranged side by side, and longitudinally in reference to the sheath; the second of a continuous, somewhat projecting edge. At the base of each sheath, and equal to more than half its length, there are three spreading yellow threads, and at the apex two smaller, and colourless; the last at first erect, afterwards recurved. Whole plant, even to the corolla, covered with inverted stinging hairs, which arise from glands, and transmit

through them a transparent fluid secreted by these. This fluid is also seen with the microscope scattered over the plant in little receptacles under the cuticle. There are besides these hairs, others, smaller, barbed along their whole length, but not proceeding from obvious glands. Similar hairs are observed in greater numbers in *L. nitida*, and probably in other species. They are possibly merely abortive appearances of the more formidable pubescence.

We received seeds of this plant, under the name of *Blumenbachia insignis*, from Dr Fischer of Göttingen, in February 1827, without any notice of its native country, which, however, without doubt is South America. The peculiarities of the germen and calyx which I have adopted as the specific character, may be considered enough to constitute this a genus distinct from *Loasa*; but however true it is that natural genera are formed in innumerable instances on modifications of these parts, yet I conceive that this is an example, among many others, in which a good rule, if applied indiscriminately, would disunite individuals among whom nature has established the closest affinity. In the whole habit, appearance and structure, with the exceptions above stated, this is a *Loasa*.

Polemonium Richardsonii.

P. *Richardsonii*; cauli piloso, angulato, erecto; foliis pinnatis, multijugis, pinnis ovato-rotundatis, mucronulatis, subtus pubescentibus; floribus corymbosis, nutantibus, corollæ segmentis obtusis, crenulatis; radice subfusiforme, longissima.

Description.—*Root* perennial, very long, in the old plant 3 or 4 feet, yellow, about as thick as the finger, somewhat branched at the apex, descending deep into the sand, and tending to bind it together, very much resembling liquorice. *Stem* erect, herbaceous, green, purplish at the base, branched. *Branches* axillary, chiefly from the lower part of the stem and the crown of the root, ascending, as well as the stem angular, and having a slightly prominent line along each flat side. *Leaves* pinnate, with an odd leafet; common footstalk channelled, from the leafets being narrowly decurrent, and forming a border on each side; pinnæ very numerous on the root-leaves (10 or 12 pairs), fewer on the stem-leaves, quite entire, a very few shewing a tendency to become lobed, sessile, rotundato-ovate, mucronulate, oblique, pubescent below, naked above, somewhat fleshy, middle rib channelled, veins obscure; root-leaves depressed, and spreading, star-like, on the ground, at least when the plant is young. *Flowers* in terminal corymbs, buds nodding, when fully expanded fronting outwards, large, pedicels round. *Calyx* persisting, ovate, as well as the stem, branches, and pedicels, villous, and slightly viscid, 5-cleft; segments ovate, pointed, spreading a little while the corolla is fully expanded. *Corolla* slightly marcescent, but soon after falling, perfume faint but disagreeable, salver-shaped; *tube* nearly as long as the calyx, yellow and somewhat plaited in its upper half, colourless below; *limb* of five broad, obovate, spreading segments, minutely crenated, pale purple marked with deeper veins, darker at its base, where on the outside it is very slightly pubescent. *Stamens* five, included; *filaments* connivent, slender, flattened, awl-shaped, contracted at the base, inserted into the apices of small, connivent, hairy valves, which arise within the throat of the corolla, alternately with the segments of the limb; *anthers* sagittate, curved inwards, large, white; *pollen* white. *Germen* small, ovate; *style* filiform, equal in length to the filaments; *stigma* in most of the flowers 4-cleft, revolute, pubescent.

Seeds gathered by Dr Richardson in 1825, from plants growing in deep sandy soil on Great Bear Lake, in 66° North Latitude, and received from him in this country in 1826. The species flowered in a cold frame at the Royal Botanic Garden, Edinburgh, in the beginning of October 1827.

I have a double reason for dedicating this species to our excellent and indefatigable countryman. It is the first which has flowered among the

plants raised from seeds received from him last year; and while I was in the act of writing the description, I received information of his having arrived in Edinburgh from his last successful survey of the shores of the Arctic Sea.

Salpiglossis atro-purpurea.

S. *atro-purpurea;* foliis lanceolato-ellipticis, convexis, sinuatis, superioribus integerrimis, linearibus; stylo edentulo.

Description.—*Stem* herbaceous, procumbent for a little way at the base, afterwards erect, 2 feet high, somewhat flexuose, branching. *Branches* ascending. *Leaves* scattered, varying considerably in shape, the larger (3–4 inches long, 1¼–1½ broad) lanceolato-elliptical, often nearly elliptical or ovato-elliptical, flaccid, and folded back from the middle rib, sinuated, the segments generally blunt and entire, sometimes sharp and occasionally toothed on their sides, decurrent along the petiole, which is nearly equal in length to the leaf; upper leaves lanceolato-linear and entire, and on the flowering branches passing into linear *bracteæ*. *Flowers* on loose terminal panicles. *Pedicels* opposite to, or alternate with, the bracteæ, stout, slightly curved upwards, as well as the stem and branches, cylindrical. *Calyx* persisting, oblong-ovate, 5-cleft, segments acute, 5-angled, angles deep green, the intervening spaces paler and rugose. *Corolla* large, inserted into the receptacle, veined, rich deep purple within, more lurid on the outside, funnel-shaped; *tube* cylindrical, twice the length of the calyx; *throat* much inflated, a little more on its lower side, and half as long again as the tube; *limb* spreading, 5-cleft, segments obcordate, the largest above, the two smallest below; *stamens* four didynamous, with the slender rudiment of a fifth between the two longer, inserted into the orifice of the tube of the corolla; *filaments* slightly flattened, purple towards the anthers, paler below; *anthers* very large, yellow, ovate, bi-lobular, bifid at the base, the outer lobe always the largest; *pollen* yellow. *Germen* conical, channelled on both sides, bilocular, green; *style* single, terminal, slender below, transversely flattened and much expanded above, without lateral teeth, pale green, longer than the filaments, included; *stigma* truncated, cleft along its extremity, green. The stem, branches, leaves, pedicels, and calyx, are covered with a soft, glandular, glutinous pubescence, which appears more sparingly on the outside of the corolla, and on the filaments. When fading, the upper part of the corolla is nearly deliquescent, the decay beginning in round transparent spots, the lower part is somewhat marcescent.

It is impossible to suppose this the same species with the *S. straminea* of Hooker, Ex. Fl. t. 229; yet as the leaves probably vary, it may not be easy to find good specific characters. It seems a larger and more robust plant, the branches and pedicels being considerably stouter and more straight, and the stamens inserted higher in the tube. It first flowered in the greenhouse of Mr Neill, Canonmills, Edinburgh, from seeds sent by Dr Gillies from hills fifty miles beyond Mendoza. Both the species have flowered freely in the stove of the Royal Botanic Garden, Edinburgh, in September and October, the seeds having been sent from the Cordillera by Mr Cruckshanks in 1826. Both differ from the *Salpiglossis* figured by Ruiz and Pavon, Prodr. Fl. Peruv. et Chil. t. 19. in the segments of the corolla being larger, more spreading, and obcordate rather than emarginate, and in the absence of teeth on the style. Our specimens of *S. straminea* have the tube of the corolla as long as in the *S. atro-purpurea*, which is considerably longer than in Dr Hooker's figure; and in this respect both agree with the figure of Ruiz and Pavon.

Verbena barbata.

V. *barbata;* caule suffruticoso, erecto, tetragono, angulis barbatis; foliis petiolatis, cordato-ovatis, acutis, crenato-serratis, utrinque pubescentibus; spicis terminalibus, strictis, gracilibus.

DESCRIPTION.—*Stem* somewhat woody below, square, contracted at the origins of the leaves, streaked, rough, angles prominent, and covered with hard spreading hairs. Our plant is branched at the bottom; but as the branches are herbaceous, and stand right up like as many stems, without being farther divided, it is possible that both the woody structure, and the branching, may have arisen from the leading shoot having been cut down. *Leaves* petioled, opposite, decussating, spreading, cordato-ovate, reticulato-veined, pubescent on both sides, rather unequally crenato-serrated. *Spikes* terminal, solitary, slender. *Bracteæ* subulate, longer than the little pedicel. *Flowers* small, solitary. *Calyx* green, channelled, more than twice the length of the bracteæ, pubescent, hairs erect. *Corolla* pale pink, funnel-shaped, pubescent, hairs reflexed; *tube* twice the length of the calyx; *limb* erect. *Anthers* included; *filaments* inserted into the tube of the corolla. *Germen* ovate; *style* filiform; *stigma* hooked, exserted just before the bud fully expands, but afterwards included by the elongated corolla.

This species has no beauty, nor does it possess any interest except that it is new. We received the plant from Mr Hogg at New York last spring, under no name, but with the information that it had been procured from Mexico.

Celestial Phenomena from January 1. *to April* 1. 1828, *calculated for the Meridian of Edinburgh, Mean Time.* By Mr George Innes, Aberdeen.

The times are inserted according to the Civil reckoning, the day beginning at midnight.—The Conjunctions of the Moon with the Stars are given in *Right Ascension.*

JANUARY.

D.	H.	′	″		D.	H.	′	″	
2.	5	47	15	○ Full Moon.	13.	10	36	54	☌ ☽ ν ♏
2.	18	36	37	☌ ☽ ♄	16.	2	27	22	☌ ♀ γ ♑
4.	15	2	2	♃ 3′ 20″ N. of ♂	16.	5	12	10	☌ ☽ ☿
4.	17	57	53	☌ ☽ 1 α ♋	16.	6	33	51	♄ 3′ 18″ S. of δ ♊
4.	19	3	0	☌ ☽ 2 α ♋	17.	0	20	48	● New Moon.
5.	16	24	10	☌ ☽ ο ♌	17.	3	53	28	☌ ☽ ♅
6.	2	29	45	☌ ☽ π ♌	17.	12	16	52	☌ ♀ δ ♑
8.	0	59	12	☍ ☉ ♄	18.	6	44	17	Im. I. sat. ♃
8.	5	5	39	☌ ☽ υ ♌	18.	19	2	45	☌ ☽ ♀
9.	17	30	37	☌ ♀ ϑ ♑	19.	7	–	–	☌ ☉ ♅
10.	4	36	8	Im. II. sat. ♃	20.	23	44	21	☉ enters ♒
10.	7	9	41	☾ Last Quarter.	22.	11	41	51	☌ ☽ ε ♓
10.	11	17	37	☌ ☽ α ♍	23.	20	44	4	☽ First Quarter
11.	4	50	51	Im. I. sat. ♃	24.	5	47	18	☌ ♃ 2 α ♎
11.	11	11	0	☌ ☽ λ ♍	26.	10	2	7	☌ ♂ 4 ζ ♎
11.	22	53	6	☌ ☽ ♃	26.	13	33	25	☌ ☽ ε ♉
12.	1	21	48	☌ ☽ 2 α ♎	27.	3	6	7	Im. I. sat. ♃
12.	5	23	56	☌ ☽ ♂	29.	22	27	22	☌ ☽ ♄
12.	18	36	24	☌ ☽ 4 ζ ♎	30.	1	5	14	☌ ♂ κ ♎
12.	19	30	9	☌ ♀ ν ♑					

FEBRUARY.

D.	H.	′	″	
1.	0	2	10	☌ ☽ 1 α ♋
1.	1	4	52	○ Full Moon
1.	1	7	28	☌ ☽ 2 α ♋
1.	1	22	25	☌ ♀ λ ♒
1.	22	3	5	☌ ☽ ο ♌
2.	8	23	36	☌ ☽ ♌
3.	4	59	32	Im. I. sat. ♃
3.	7	17	-	Sup. ☌ ☉ ☿
4.	2	42	11	Em. III. sat. ♃
4.	5	19	55	☌ ♂ λ ♎
4.	10	44	28	☌ ☽ ν ♌
5.	12	35	0	☌ ♀ φ ♒
7.	17	45	46	☌ ☽ λ ♍
8.	8	20	50	☌ ☽ 2 α ♎
8.	10	22	50	☌ ☽ ♃
8.	19	56	17	☾ Last Quarter.
8.	22	13	17	☌ ♂ β ♍
9.	2	9	14	☌ ☽ 4 ζ ♒
9.	10	45	33	☌ ☽ ϑ ♎
9.	17	8	52	☌ ☽ ♂
9.	18	55	29	☌ ☽ ν ♏
11.	4	3	45	Im. II. sat. ♃
11.	4	29	17	Im. III. sat. ♃
11.	11	17	8	☌ ♂ ν ♏
12.	1	21	16	Im. I. sat. ♃
13.	17	19	4	☌ ☽ ♅
13.	20	22	0	☌ ☽ β ♑
15.	10	46	51	● New Moon.
16.	4	35	23	☌ ☽ ☿.
17.	18	3	5	☌ ☽ ♀
18.	21	5	30	☌ ☽ ι ♓
19.	1	24	0	☌ ☽ ζ ♓
19.	3	14	44	Im. I. sat. ♃
19.	14	38	19	☉ enters ♓
22.	14	39	39	☽ First Quarter.
22.	17	38	15	☌ ☽ 1 δ ♉
22.	18	9	45	☌ ☽ 2 δ ♉
22.	20	34	32	☌ ☽ ε ♉
26.	0	10	26	☌ ☽ ♄
26.	5	8	13	Im. I. sat. ♃
28.	6	46	42	☌ ☽ 1 α ♋
28.	7	52	4	☌ ☽ 2 α ♋
29.	5	1	39	☌ ☽ ο ♌

MARCH.

D.	H.	′	″	
1.	14	59	25	☌ ♂ π ♌
1.	18	52	58	○ Full Moon.
1.				☿ greatest elong.
2.	16	51	0	☌ ☽ ν ♌
3.	8	39	18	♀ 29″.5 N. of ζ ♓
5.	23	10	31	☌ ☽ λ ♍
6.	1	30	9	Im. I. sat. ♃
6.	13	47	19	☌ ☽ 2 α ♎
6.	16	58	51	☌ ☽ ♃
7.	0	58	44	Im. II. sat. ♃
7.	7	44	44	☌ ☽ 4 ζ ♎
7.	16	27	57	☌ ☽ ϑ ♎
9.	2	13	50	☌ ☽ ♂
9.	5	15	54	☾ Last Quarter.
12.	4	17	40	☌ ☽ ♅
12.	5	14	30	☌ ☽ β ♑
13.	3	23	43	Im. I. sat. ♃
14.	3	31	48	Im. II. sat. ♃
15.	21	33	49	● New Moon.
16.	3	23	44	☌ ☽ ☿
17.	7	23	8	☌ ☽ ι ♓
17.	11	38	23	☌ ☽ ζ ♓
18.	0	17	15	Im. III. sat. ♃
18.	2	26	1	Em. III. sat. ♃
18.	6	15	-	Sup. ☌ ☉ ☿
20.	14	42	16	☉ enters ♈
21.	2	4	48	☌ ☽ 1 δ ♉
21.	2	35	44	☌ ☽ 2 δ ♉
21.	4	57	40	☌ ☽ ε ♉
21.	23	45	44	Im. I. sat. ♃
23.	9	55	56	☽ First Quarter.
24.	8	0	50	☌ ☽ ♄
25.	4	14	53	Im. III. sat. ♃
26.	2	7	27	♀ near ρ ♈
26.	14	24	47	☌ ☽ 1 α ♋
26.	15	30	27	☌ ☽ 2 α ♋
27.	12	42	32	☌ ☽ ο ♌
27.	22	41	0	☌ ☽ π ♌
29.	1	39	28	Im. I. sat. ♃
29.	11	5	24	☌ ♀ δ ♈
30.	0	22	15	☌ ☽ ν ♌
31.	10	22	37	○ Full Moon.

Times of the Planets passing the Meridian.

JANUARY.						
	Mercury.	Venus.	Mars.	Jupiter.	Saturn.	Georgian.
D.	H. ′	H. ′	H. ′	H. ′	H. ′	H. ′
1	10 44	13 34	7 44	7 51	0 33	13 17
5	10 52	13 40	7 37	7 37	0 15	13 2
10	11 6	13 45	7 30	7 20	23 54	12 44
15	11 20	13 51	7 22	7 3	23 33	12 21
20	11 34	13 55	7 14	6 45	23 11	12 3
25	11 50	13 59	7 6	6 27	22 49	11 43

FEBRUARY.						
	Mercury.	Venus.	Mars.	Jupiter.	Saturn.	Georgian.
D.	H. ′	H. ′	H. ′	H. ′	H. ′	H. ′
1	12 14	14 5	6 55	6 3	22 21	11 23
5	12 22	14 7	6 49	5 48	22 5	11 8
10	12 38	14 10	6 41	5 30	21 44	10 49
15	12 54	14 12	6 33	5 11	21 23	10 31
20	13 6	14 15	6 25	4 52	21 3	10 12
25	13 16	14 17	6 17	4 33	20 42	9 54

MARCH.						
	Mercury.	Venus.	Mars.	Jupiter.	Saturn.	Georgian.
D.	H. ′	H. ′	H. ′	H. ′	H. ′	H. ′
1	13 17	14 20	6 10	4 14	20 22	9 36
5	13 9	14 21	6 2	3 58	20 5	9 20
10	12 50	14 24	5 51	3 38	19 45	9 1
15	12 21	14 26	5 45	3 17	19 25	8 44
20	11 45	14 29	5 37	2 57	19 6	8 24
25	11 13	14 32	.. 28	2 35	18 47	8 5

I observed the end of the Lunar Eclipse of the 3d November, at $18^h\ 21'\ 44''$ *Mean Time*, allowing for a small error of the clock. During the eclipse, the Moon's dark limb was so well defined, that it was difficult to determine exactly when the Earth's shadow left the Moon's north limb, as the penumbra continued for several minutes after the termination of the eclipse.—G. I.

Proceedings of the Wernerian Natural History Society.

Continued from p. 183. of the preceding Volume.

1827, *April* 7.—Robert Jameson, Esq. President, in the chair.—Mr W. A. Cadell read a description of the Hindoo Smiths' Bellows, with remarks on the occurrence of a similar bellows in Europe, as illustrative of the Indian origin of the Gypsies.—[This paper will be found in the preceding Volume

of this Journal, p. 84, *et seq.*]—Mr Robert Bald, mining engineer, read Observations on the Coal-field and accompanying Strata in the vicinity of Dalkeith in Mid-Lothian, and exhibited a section of that coal-field.—[This interesting communication is printed in the present Number, p. 115. to p. 122.]—The Rev. Dr David Scot of Corstorphine, then read an essay on the Semamith of Solomon, Prov. xxx. 25., commonly translated *spider*, but which he shewed to be a species of lizard.—[This paper is also printed in the present Number, p. 30, *et seq.*]—At this meeting, Mr James Alexander Vintress exhibited a new Stereometer, or instrument for ascertaining the specific gravity of powders, invented by him.

April 21.—The President in the Chair.—The Secretary read an account of interesting Works of Art lately discovered in the ruins of Selinus, by two English architects, Messrs Harris and Angel; communicated by Dr Traill of Liverpool.—[This communication will be found in the preceding Volume of this Journal, p. 165, *et seq.*]—Likewise a notice by James Wilson, Esq. regarding a living specimen of the Puma, or American Lion, lately presented to Professor Jameson The Rev. Dr Scot then read a memoir on the "Hyssop" of the Sacred Writings.—Dr R. E. Grant exhibited several living specimens of the Virgularia juncea of Lamarck, from deep places in the Frith of Forth, and made some remarks on the structure of this zoophyte. Professor Jameson then exhibited and described a specimen of the Ibis sacra of Africa, brought home by Major Denham; the horns of a Wapiti Deer, brought from California by Captain Ferguson; a Balsa, or boat or float, made of two bundles of straw or reeds, used in Peru for crossing rivers, or passing through the surf on the coast; and a specimen of the Peccari Hog, presented to the College Museum by Mr Shenley.

May 19.—Rev. Dr Brunton, V. P. in the Chair—At this meeting the following communications were read. 1. An account of experiments on the Magnetic Influences of the Heat produced by the solar rays, by Mark Watt, Esq.—[Preceding Volume of this Journal, p. 170. *et seq.*] 2. Notice of a remarkable marine animal, probably of the cetaceous tribe, observed in the Mozambique Channel, communicated by Dr Traill of Liver-

pool, with a drawing. 3. Notice regarding the native country of the Potato, *Solanum tuberosum;* communicated by Aylmer Bourke Lambert, Esq.—[Printed in the preceding Volume of this Journal, p. 192.] 4. Account of the trachea of the Emu of New Holland, and of the laryngeal pouch of the Rein-deer, by Dr Traill. 5. Description of a remarkable Aurora borealis, seen at Edinburgh 16th January 1827, by Mr Blackadder. [Printed in the preceding Number, p. 342, &c.]

The Rev. Dr Fleming of Flisk, being present, laid before the meeting some remarks on the genus Scissurella, with a description of a recent British species found by him in Shetland.—A living specimen of the *Lemur tardigradus*, or *Tailless Macauco*, brought from China by Mr Baird, was exhibited; and some notes by that gentleman regarding its peculiarities, were read.—[See this Journal for April–June 1827, p. 195.] A living specimen of the *Viverra Mungos*, or Mongouste, from Madras, was also exhibited; and some remarks, by Mr Alexander Adie *junior*, on the habits of the animal since it came into his possession, were read. Lastly, Specimens of native alum from Chili, and of limestone, containing shells, from the Inca's Bridge, at a very great elevation, sent home by Dr Gillies of Mendoza, were laid before the meeting.

Nov. 24.—The Society met for the election of Office-bearers for the year 1828, when the following gentlemen were unanimously chosen.

PRESIDENT.
ROBERT JAMESON, Esq.

VICE-PRESIDENTS.

David Falconer, Esq.	Dr Robert Knox.
Major-General Straton.	G. A. W. Arnott, Esq.
Secretary, Pat. Neill, Esq.	*Librarian*, James Wilson, Esq.
Treasurer, A. G. Ellis, Esq.	*Painter*, P. Syme, Esq.

COUNCIL.

John Stark, Esq.	Henry Witham, Esq.
Dr Andrew Coventry.	Dr John Aitken.
Dr R. E. Grant.	Dr Walter Adam.
Dr John Boggie.	E. W. A. Drummond Hay, Esq.

Major-General STRATON, V. P., in the chair.—The Rev. Dr Scot of Corstorphine read a communication, shewing, that the Nitre of the Sacred Scriptures is the same substance as the Na-

tron of the ancient Egyptians, or the Native Soda of modern chemistry.—Professor Jameson then read an account of a new magnetical instrument called the Solar Compass, invented by Mark Watt, Esq., and exhibited the instrument itself.—[This interesting paper is printed in the present Number of this Journal, p. 16, *et seq.*, and a figure of the Solar Compass is given in Plate I.]

SCIENTIFIC INTELLIGENCE.

METEOROLOGY.

1. *Great Fall of Rain at Bombay.*—In a letter from Mr Scott *jun.* of Bombay, he says, that, during the first twelve days of the rainy season, 32 inches of rain fell, and that then all the roads became like rivers. In England, the average fall for the whole year is 32 inches,—the quantity which fell at Bombay in the course of twelve days.

HYDROGRAPHY.

2. *Colour of the Red Sea.*—The colour of the Red Sea has given rise to various investigations. Dr Ehrenberg, who accompanied Dr Hemprich, ascertained that it was caused by a species of *Oscillatoria*, one of those small plants which are intermediate between animals and plants.

3. *Melted Snow employed as Drink.*—A fact related by Captain Parry, proves that melted snow is not so unwholesome a drink as it has hitherto been supposed. He and his crew made use of it for three years without being affected with the glandular swellings to which, according to the common opinion, they should have been exposed by employing this beverage.

4. *Notice regarding the Falls of Rewah, and a remarkable Conical Hill at Myhur.*—I left Benares with my regiment on the 5th of October, and arrived at Jubbulpoor on the 9th of November 1826. Our route lay through Mizapoor, Rewah, and Myhur. When at Rewah, I left the corps for two days, and, in company with some of our officers and their ladies, went to visit the stupendous falls of the Lounse, or Loonse, generally called the falls of Rewah. They are three in number, and the

largest of them is allowed to be the grandest yet discovered, Niagara not excepted. You may hear the noise of the fall at the distance of many miles; but the sight which is presented to you on your nearer approach is grander than I can possibly find words to express. The water dashes over a perpendicular rock 173 feet high, in one unbroken stream; and the vapour which rises from the bottom appears like an immense cloud of white smoke, and will wet one to the skin 500 yards off. The second fall is not quite so grand in respect to height, but I think more beautiful in appearance. In the very middle of it stands a rock, in the shape of a tall pillar, and so slight that you would expect to see it washed over by the stream which continually dashes around it. The top of it may be about seven or eight feet in diameter; and on that pinnacle lives an old Fakeer, who has not been off it for the last thirty years. He is supplied with food by some of the neighbouring villagers, who regard him as constantly employed in contemplation of the deity. At Myhur we halted a day, which I spent in visiting the town, and some adjacent ruins, which are well worthy of note. About a quarter of a mile to the south-west of the town, there is a very curious hill, in the shape of a cone, very steep on all sides, and on the top of it is erected a small Hindoo temple, to which you ascend by a stair built in a straight line up one side of the hill, which is nearly perpendicular. It consists of 523 steps, each about 14 inches high. On going up I had to rest very frequently; and, on looking down, I sometimes felt myself so giddy, that had I not been supported by the bushes at each side, I dare say I should have rolled down to the bottom. This place was built long ago by one of the Myhur's Rajahs, and has always been looked upon by the Hindoos as a most holy spot. From thence to Jubbulpoor the country is almost all jungle, and the roads very bad; and we were all highly pleased when we arrived at the end of our journey.—*Letter from an Officer of the 5th Extra Regiment of Native Infantry, to his Father.*

NATURAL PHILOSOPHY.

5. *Distances at which Sounds are heard.*—I recollect of being, many years ago, at the west end of Dunfermline, and hearing part of a sermon then delivering at a tent at Cairneyhill. I

did not miss a word, although the distance must be something about two miles. It was the late Dr Black of Dunfermline who preached, and who perhaps has seldom been surpassed for distinct speaking and a clear voice. The sound was such as I should have expected, in favourable circumstances, at a quarter of a mile. The wind, which was steady, but moderate, came in the direction of the sound. There are some miraculous stories of sermons being heard at many miles distance; but I did not view it in that light. I was riding westward, and at length saw the Doctor finishing his sermon, otherwise I should have doubted whether he had been at such a distance. Whether the sound had run along the road, as in a tube, I cannot say. I recollect little of what sort of road it is; part, I think, has pretty good dikes, which might guide and confine the sound, aided by the wind. Some gaping ploughmen may surely be heard calling to their horses more than two miles; and, were fishwives in the open country, their eloquence would probably extend still farther. Unfortunately, most people, when they call loud, are not intelligible. In Scripture, there seem to be instances of persons being heard far speaking from mountain tops, but perhaps they used a trumpet.—H. M.

6. *Capillary Action.*—From a series of interesting experiments performed by Magnus, and recorded in Poggendorf's Journal, St. 5. 1827, it follows, that the rising of fluids through a bladder, as detailed in some well known experiments, is an effect of capillary action, and that it can be explained, if we admit that different fluids force their way through capillary openings more or less easily, according to their degree of tenuity.

7. *Farther Observations made on the Solar Compass.*—1. That the effect produced by the hairs or piles of velvet is much greater when the velvet is placed over the points of the needle, than when it is made to surround the circle of cork into which the needles are fixed. 2. That it seems a farther improvement to place south and north poles alternately outwards. 3. I have twice observed it move about 10° to the influence of the full moon, when the atmosphere was very clear. 4. That its sensibility seems greatly diminished by cold, and that when the thermometer stood at 30° in the shade, it did not move to the influence of the sun at this season, above three hours, from 11 A. M.

to 2 P. M. 5. That, at this season of the year (November), a circle of cork, with 20 or 30 needles fixed inside of the circle, having all their points nearly meeting at the centre, and suspended by any very tenuous filament, is more sensitive than that form of the instrument which traverses on a pivot.—M. W.

CHEMISTRY.

8. *Metal of Alumina.*—M. Oersted is stated to have obtained the metal of alumina, by employing the chloride of that earth. Pure alumina is heated to redness, and then intimately mixed with powdered charcoal; the mixture is introduced into a porcelain tube; and, after heating to redness, dry chlorine gas is passed over it. The charcoal reduces the alumina, the metal combines with the chlorine, and oxide of carbon is also formed. The chloride of aluminum is soft, crystalline, and evaporates at a little above the temperature of boiling water; it readily attracts moisture from the air, and becomes hot when water is added to it. By mixing with an amalgam of potassium, containing much of the latter, and immediately heating the mixture, chloride of potassium is formed, and the metal of the alumina combines with the mercury. The amalgam quickly oxidises by exposure to the air. Being subjected to distillation, out of the contact of air, the mercury is volatilized, and a metallic button is left, which has the colour and splendour of tin. M. Oersted has ascertained many properties belonging to the new metal, and its amalgam, which he promises to publish speedily.—*Phil. Mag. Nov.* 1827.

MINERALOGY.

9. *Largest known masses of Native Platina.*—Before Humboldt's return from America, small grains only of platina were known to naturalists. On his arrival in Prussia, he deposited in the Berlin Museum a native specimen of Peruvian platina, weighing 1083 grains. For twenty years, this remained the largest specimen in Europe. Since 1822, the Museum of Madrid has been enriched with another American mass of platina, weighing 11,641 grains. A few months ago, a still more remarkable mass was discovered in the Urals, weighing $10\frac{54}{99}$ Russian pounds. It is deposited in the Museum of St Peters-

'burg. The relative weights of the platina of Berlin, Madrid and Petersburg are as 1, 11, 75.

10. *On the Ostranite, a New Mineral Species;* by Aug. Breithaupt.—This substance has only as yet been found in the crystallized state, and in the form of a right rhomboidal prism, slightly modified on the acute lateral edges, and deeply truncated on the angles of the bases. M. Breithaupt derives this form from a rhomboidal octahedron, in which the three axes are to each other as the numbers 1000, 2059, and 1854. The adjacent faces on the same pyramid form between them angles of 128° 14', and 133° 42'. Their inclination upon the base is 71° 56'. The angles of the rhomboidal prism are 96° and 48°. There is a scarcely perceptible cleavage parallel to the small diagonal of the base. The lustre of the ostranite is vitreous; its colour is clove-brown. Its hardness is intermediate between that of orthoklase and quartz. It is very brittle; its specific gravity varies between 4.32 and 4.40. The crystals of this substance, which served as a basis to the preceding determination, were about an inch long; they formed part of the collection of the Chev. Heyer, of Dresden. They came from Norway, whence they were brought by M. Nepperschmidt, of Hamburg. Nothing is known precisely with regard to their geognostical relations. Some trials of this substance have been made with the blowpipe. Treated alone, it does not melt, but its colour becomes paler. With borax it melts, but with difficulty, into a transparent glass; it is insoluble in nitric acid. From these characters, and the place which it occupies in the system, M. Breithaupt presumes that this substance is a new metallic oxide. He gives it the name of *ostranite*, derived from that of the goddess Ostra, in order that, should a new metallic base be discovered in this oxide, the name of *Ostran* may be given it, as has been done with regard to titanium and titanite, tantalum and tantalite, &c.

11. *On the Rose-coloured Petrosilex of Sahlberg;* by M. Berthier.—M. Berthier proposes to submit to a chemical examination the petrosilex of Sahlberg, in Sweden. This mineralogist observes, that the petrosilexes are erroneously considered as varieties of compact felspar. It is one of those vague denominations with which science is still disfigured, and which only serve to lead into error, or to deceive us with regard to what we are ig-

norant of. The petrosilex of Sahlberg; not only does not belong to compact felspar, but constitutes a new species, composed of silica, alumina, soda, and magnesia.—*Bullet. Univ. Aout* 1827.

GEOLOGY.

12. *From what Countries have the Islands in the West Indies derived their Plants?*—M. Moreau de Jonnes, who supposes that the deposits, whether calcareous or volcanic, of the Antilles, have been left dry by the sea at a later period than the great continents, had, in support of this opinion, to inquire into the origin of their vegetable population, and to endeavour to find out by what agents, and from what countries, each of their plants, was transported to them. For this purpose he prepared, during his residence at Martinique, mixtures of earth adapted for vegetation, and in which, he was well assured, there existed no germs of plants. He exposed them with the requisite precautions, and separately, to the action of tempestuous rains, to that of different winds, of birds of passage, and of various currents, and counted, as far as was possible, the number of species which each of these causes produced. He also endeavoured to estimate how far man himself may contribute to this end, by transporting seeds or germs of plants in the water brought from other countries in ships for the use of their crews, among the matters used for packing foreign goods, among wood and fodder, as well as in ballast, and among the hair of animals. The most powerful and constant of the natural agents appears to him to be the great equatorial current of the Atlantic. He found that, in the space of two months, it brought seeds of 150 different species; but all seeds are not capable of being equally transported by all the agents, and to be able to arrive at a given distance in a condition to reproduce their species, they require to possess certain conditions of lightness, mobility, resistance to destruction, difficulty or facility of germination, and others of a like nature. Thus, among the 150 species of seeds brought by the current, there were only twenty-six that germinated. With regard to the action of man, M. de Jonnes thinks it much superior to that of natural agents, and imagines that, in a few

centuries, it is capable of entirely changing the relations established by them in a country immediately after its origin.—*Hist. de l'Acad. Roy. des Sc.* t. vi. p. cxiii.

13. *Fossil Skeletons of Guadaloupe.*—Cuvier finds that the calcareous mass in which these human skeletons is imbedded, contains land-shells and sea-shells of the same species as those met with in the neighbouring sea and adjacent land; that, therefore, the mass is modern, and the product of some encrusting springs which run towards the place where the skeletons are met with.

14. *Organic Remains of the Alluvium and Diluvium of Sussex.*—In the alluvial and diluvial deposits of Sussex, the remains of animals hitherto discovered are very few, compared with those found in other countries of England. Mr Mantell mentions but two kinds as having been noticed (Geology of Sussex, p. 284.), viz. the elephant and horse. A short time since some labourers, who were employed in deepening the bed of the river Ouse, which flows through a chalk valley by Lewes, and empties itself into the sea at Newhaven, discovered, in a bed of sand beneath the blue alluvial clay that forms the marshy tract called Lewes Levels, the entire skeleton of a deer of a very large size. The horns were quite perfect, and measure 3 feet in height, and 3 feet 2 inches at their greatest width. The antlers had seven points, and resembled in their form those figured by Cuvier of the Canadian deer. The greater part of the skeleton was destroyed by the carelessness of the workmen, and a few bones only preserved. Of these, the tibia measures 14½ inches in length, and the ulna 15 inches to the end of the olecranon. The ramus of the lower jaw (imperfect) 11 inches. These remains are in Mr Mantell's collection at Castle Place, Lewes. Still more recently, bones of the deer have been found in the diluvial gravel that forms the low line of cliffs to the west of Brighton, at Copperas Gap near Southwick. These, like all the other bones that have been discovered in this bed, were broken, and promiscuously intermingled with the soil. Two teeth of a species of deer, and portions of several humeri, were identified. Part of the tusk of an elephant was also found with them, and pebbles of granite, in a state of decomposition. Teeth of the Asiatic elephant have been met with in the loam-

pits at Hove. The Reverend H. Hoper of Pontslade has these interesting remains in his possession.—*Phil. Mag.* Nov. 1827.

15. *Hansteen's projected Journey to Siberia.*—Our distinguished correspondent Professor Hansteen of Christiania writes to us as follows: "I am still living in hopes that I shall be able to set out on my journey through Siberia to Ochotz in February or March 1828. Being myself not sufficiently experienced in natural history, I shall be accompanied by a young mineralogist, Keilhau, of this place (Christiania); and Professor Erman of Berlin has offered me the company of his son Dr Erman, and assures me that Baron von Humboldt and Baron von Buch are ready to furnish him with the necessary instructions in geological and geognostical science."

16. *Partch's Journey through Transylvania.*—Partch of Vienna, an active and acute geologist, was sent by the Austrian government, in 1826, into Transylvania. He remained in that very interesting, but much neglected, part of Europe from April 1826 to February 1827. In defiance of all the difficulties opposed to him in his progress through a country without roads, covered with extensive forests, and affording only the most miserable accommodation to the traveller, he made a full survey of its mines and saline districts, and of the rock formations over great tracts. Boué gave him the use of the geological maps he constructed during his perilous expedition through that country. He is inclined to refer the saliferous sandstone of the middle districts to the tertiary class of rocks. Boué asks, in a communication to us, Is there not, in Transylvania, a saliferous deposite in the Carpathian sandstone, of the same age with the secondary salt formation, or of some of the gypsums of the Alps, and also a more recent deposite connected with that tertiary molasse which is of the same age with the salt in the blue marl of the Appenines and of Sicily? Boué is of opinion that nearly the whole of the molasse takes the place of the blue tertiary marl, which is higher or newer in the series than the Paris coarse marine limestone: still the position of the lower Nagelfluhe along the Alps is dubious.

17. *Fossil Remains of Quadrupeds in the Tertiary Rocks of Vienna.*—During the course of last summer, there was found in the tertiary sand (above the blue marl with shells), near to

the Botanic Garden at Vienna, fragments of the *Mastodon angustidens*, and also of the *Anthracotherium*. M. Fitzinger has described and figured them in a pamphlet lately published. An under jaw of the *anthracotherium* has been found in the lignite or brown coal of Schauerleithen, near Neustadt, in the vicinity of Vienna, which lignite lies in the blue marl. It is also worthy of remark, that such bones are also found in the coarse shelly tertiary limestone, under the blue marl; so that, judging from the bones alone, we would be disposed to consider both as belonging to the same formation,—an opinion which cannot be entertained.

18. *Von Buch's Observations and Speculations in regard to the Alps.*—Von Buch, during last summer, visited the Bavarian Alps and the Suabian Alps or Jura, and seems disposed to consider the alpine limestone ridge as recent, probably partly Jurassic and partly chalk. The same distinguished geologist read to the Academy of Munich a paper on the Hippurites found at Reichenhall; and, in Poggendorff's Annals for 1827, he has an interesting memoir on the boulders of granite, &c. spread over the Jura and neighbouring countries, in which he maintains they have reached their present situations at the time of the rising from below of the primitive mountains, which he considers newer than the tertiary. It is worthy of notice, that De Luc of Geneva published at the same time (May last) a similar memoir in the Memoirs of the Soc. de Phys. de Geneva, vol. ii. 1827, in which he states, as his opinion, that the Alps were formed after the tertiary rocks, and that the boulders were dispersed by that great rising from below of the land.

19. *Boué's Memoir on European Formations, and their probable Origin.*—One of the most interesting memoirs lately published, is that whose title we have just given. It appeared in the Journal of Leonhard for July 1827. Unfortunately the promised map has not been published.

20. *Dr Boué on Secondary Rocks.*—Dr Boué, during a visit to Solothurn, saw, along with Professor Huggy, the shell limestone (muschel kalkstein) forming protuberances under the Jura limestone, and the rauchwacke, or porous magnesian limestone, with cuneiform masses of gypsum. Above these he found the following arrangement:—lias and its marl; the sand

of the inferior oolite; then great masses of oolite and compact limestone; a thick bed of contorted, unstratified, rather crystalline, limestone, without shells; and above this, near to Solothurn, an upper Jurassic deposite, with ammonites, encrinites, crocodiles, and tortoises. Dr Boué is of opinion that the Swiss Jura does not contain any Jurassic deposites newer than the coral rag; and further, that the equivalent for the coral rag is nearly wanting in the German Jura.

BOTANY.

21. *Signs of Increase, Maturity, and Decay in Trees;* by M. Baudrillac.—The qualities of wood depend much on the state of the tree when cut down. It appears from the experiments of M. Hartig upon wood applied as fuel, that trees which have attained maturity without passing into decay, are the best for the production of heat. Thus the value of an elm of 100 years is to that of one of 30 years, as 12 is to 9; that of an ash of 100 years to one of 30 years, as 15 to 11. When the trees begin to decay, their value rapidly diminishes: thus, if an oak of 200 years yields wood worth 15 francs per corde, a tree of the same kind passing to decay yields wood only worth 12 francs. When the wood is used for other purposes, the advantages conferred by a mature and healthy state are still more considerable. The common elm, growing in a forest, and in good earth, acquires its full increase in 150 years; but it will live many ages, even 500 or 600 years. Large forest elms are cut down with advantage when of an age between 100 and 130 years, and then furnish a large quantity of building wood. The duration of the life of the elm depends much upon the soil; in a dry soil it becomes aged, as it were, in forty, fifty, or sixty years. Elms which have been lopped live for a shorter period than the others. Those which grow by the roadside, or in their plantations, may be cut when seventy or eighty years of age. In general, the increase of hard woods, as the oak and elm, is small at first; it successively augments until the twentieth or twenty-fifth year, is then uniform until the age of sixty to eighty years, after which it sensibly diminishes. For these and other reasons, it is important that trees should be cut down when they are at their mature state, and not simply when they undergo no fur-

ther increase. When the period has arrived after which the increase of the tree would be less and less from year to year, then the tree should be felled, for no advantage accrues from its remaining longer in the ground. The indications of the mature state of a tree are by no means so evident as those of decay, but still certain signs of these states, as well as of the vigorous condition of the tree, may also be observed.

I. *Signs announcing the Vigour of a Tree.*—The branches, especially towards the top, are vigorous; the annual shoots strong and long; the leaves green, vigorous, and thick, principally at the summit, and falling late in autumn; the bark is clear, fine, united, and nearly of the same colour from the foot to the large branches. If at the bottom of the veins or divisions of the thick bark there appear smaller divisions which follow from below upwards, in the direction of the fibres, and live bark be observed at the bottom of these divisions, it is an indication that the tree is very vigorous, and rapidly increasing in size. If some of the lower branches, stifled by others, are yellow, languishing, and even dead, this is an accidental effect, and is no proof of the languor of the tree. Finally, It is a sign of vigour when branches are seen at the summit of the tree rising above, and being much longer than the others; but it is to be observed, that all trees with round heads do not throw out branches with equal force.

II. *Signs which indicate that the Tree is mature.*—Generally the head of the tree is rounded; the shoots diminish in length each year, and the furthest shoots add to the length of the branches only by the length of the bud; the leaves are put forth only in spring, and become yellow in autumn before those of vigorous trees, and at this time the lower leaves are greener than the upper. The branches incline towards the horizon, and form angles sometimes of sixty or seventy degrees. These apparent signs, and the thinness of the layer deposited by the sap, indicate that the tree makes but small additions to itself, and now it should be cut down. The nature of the earth should be examined, as well as the kind of tree, to enable a judgment whether the tree should be left to increase still further, or whether it will be more proper to fell it. An exact age cannot be assigned for each species; but it has been ob-

served, that an elm, situated in an insulated plantation, may be felled with advantage when between seventy and eighty years of age.

III. *Signs of Decay in a Tree.*—When a tree becomes crowned, *i. e.* when the upper branches die, it infallibly indicates, especially for isolated trees, that the central wood is undergoing alteration, and the tree passing to decay. When the bark separates from the wood, or when it is divided by separations which pass across it, the tree is in a considerable state of degradation. When the bark is loaded with moss, lichen, or fungi, or is marked with black or red spots, these signs of alteration in the bark justify suspicions of alterations in the wood within. When sap is seen to flow from clefts in the bark, it is a sign that the trees will soon die. As to wounds or gutterings, these defects may arise from local causes, and are not necessarily the result of old age.—*Biblioth. Phys Econom.* 1826, p. 13.

22. *Botanical Excursion in Sutherlandshire.*—In an excursion which Dr Graham took with part of his pupils into the North of Scotland, in August last, the following stations for rare Scotch plants were ascertained.

Alisma ranunculoides, ditch north end of Cromarty Frith. *Radiola millegrana*, abundant on road sides near Tain *Senecio lividus*, abundant along with *S. sylvaticus*, on road sides near Lairg, Loch Shin. *Senecio Jacobæa*, var. without ray, abundant on sand-hills behind the manse of Farr, as well as in the station at Strathy where it was observed by Dr Graham two years ago. *Schœnus nigricans*, very abundant on sides of Loch Shin, and many other places in the west of Sutherlandshire. It is also extremely common in the Isle of Skye. *Carex pauciflora*, bogs, side of Loch Shin; Ben More, Assynt; and in several other stations in Sutherlandshire. *Utricularia intermedia*, bog on Ben More, Assynt; small loch two miles east of Farr church. *Apargia alpina*, Ben More, Assynt; as well as on Fonnivan, a mountain at the top of Loch Inchard, in the same station in which Dr Graham observed it two years ago. There is not a doubt that this is the plant known as *A. alpina* on the Continent, as has been proved by comparing it with authenticated specimens from several stations on the Alps and Pyrenees; but whether it be really specifically distinct from *A. autumnalis*, is a different question. There seem to be intermediate varieties, and it is more than probable that this genus, and Leontodon in particular, are subdivided by the Continental botanists beyond what is justifiable. In neither of the stations mentioned is the plant abundant. *Poa alpina*, and *Hieracium alpinum*, Ben More, Assynt; neither of these plants were observed any where else in Sutherlandshire. *Drosera longifolia*, bog north side of Ben More, Assynt far less common than *D. anglica*, which is more abundant in the north and west of Scotland than *D. rotundifolia*. *Cerastium alpinum*, Ben More, Assynt and several other mountains in Sutherlandshire. *Aira alpina*, Ben More Assynt; and Fonnivan, near the top. *Cherleria sedoides*, on all the mountains in Sutherlandshire, in the utmost profusion. *Arbutus alpina*, abun

dant in Sutherlandshire, generally on the tops of the low shoulders of the mountains. *Vaccinium uliginosum*, many of the mountains in Sutherlandshire. *Epipactis latifolia*, on limestone rocks in Assynt, and at Keoldale, parish of Durness, on the north sea. In the last place very abundant, though no station so far north in Scotland is quoted. At this place *Dryas octopetala*, *Thalictrum alpinum*, *Primula scotica*, and *Glaux maritima*, growing in contact, form a group which can be seen no where else in Britain. *Pyrus Aria*, limestone rocks, Assynt; Glencoe. *Phalaris arundinacea*, var. colorata, Island of Handa, off Scourie, west coast of Sutherlandshire. *Arabis hispida*, in abundance on several of the mountains in Sutherland, always in perfectly dry stations, and generally among broken quartz. On Benhope alone, in micaceous soil, and there only hairy; every where else quite smooth, and on Ben Hope every specimen observed was hairy. *Eleocharis multicaulis*, pools between the head of Loch Inchard and Arale, abundant. *Scilla verna*, in profusion at Far-out-Head, and on a knoll behind the manse at Farr: in both situations growing in dry peat-turf, mixed with sharp white sand. *Primula scotica*, profuse in many places along the north coast. *Pyrethrum maritimum*, abundant on sea-cliffs at Far-out-Head, and behind the manse of Farr. *Potentilla alpestris*, Ben Hope. *Astragalus uralensis*, abundant on sand-hills behind the manse of Farr. *Hieracium umbellatum*, rocky knoll behind the manse of Farr. *Asplenium marinum*, sea-cliffs behind the church of Farr. *Juncus arcticus*, cliffs behind the church of Farr, and in several places in the neighbourhood of Cape Wrath and Oldshore. *Sagina maritima*, ruined castle on the cliff behind the manse of Farr.

It is not long since the *Senecio tenuifolius* was ascertained to be a Scotch plant, growing at Woodhall, near Airdrie; Dr Graham has lately received specimens from Mr Baird, who has found it abundantly in the parishes of Lady Kirk and Swinton, particularly on the farm of Little Swinton.—R. G.

ZOOLOGY.

23. *On the tendency of Matter to become Organized.*—We noticed, on former occasions, M. Bory de St Vincent's observations on those ambiguous beings, which, during a part of their life, are collected into filaments, whose colour and general aspect are those of vegetables, and which, at certain periods, separate and assume the voluntary motion of animals. M. Gaillon, an enlightened observer, the author of an interesting memoir on the cause of the green colour in oysters, has discovered that it is produced by the *Conferva comoides*. He has seen the greenish corpuscules, which form its axis, become detached, advance with more or less rapidity, change place, and, in short, act in all respects like enchylides and cyclidia. Taking entire filaments, he forced these minute beings to separate before the time; and, in this case also, they manifested the same voluntary movements. Their propensity to associate is so great, that, whenever the young can do so, they arrange themselves, one after another, in a single line; and, when in this position, M. Gaillon thought he observed them to exude from

their substance a mucosity, which forms itself into a membrane, and entirely envelopes them *. M. Bory de St Vincent has continued to occupy himself with these microscopic transformations, having in view to penetrate to the first combinations of matter to which these corpuscules seem so near. Observing the appearances successively presented in water exposed to light, he thought he saw, for the first time, matter assume the aspect of a simple mucosity, without colour or form. If the water contains any animal substance, it produces a pellicle of this mucosity at its surface, then becomes turbid, and discloses an infinity of living atoms, if we may so call those monads, which, after being magnified a thousand times, are not so large as the point of a needle, and which yet move in all directions, with prodigious velocity. This is what M. Bory names matter in the living state. When the water is exposed to the air and light, there quickly forms what is named the green matter of Priestley, which many observers have supposed to be the first state of certain confervæ, or plants of a like nature. M. Bory thinks that it is a combination of a more general form, and only susceptible of entering into the composition of these plants, as well as of the animalcules which issue from it, and which produce them. He names this combination *matter in the vegetative state*. It is by it that the infusory animals are rendered green. Those which colour oysters, according to M. Gaillon's observations, produce this effect, as M. Bory says, only because they are themselves coloured by the green matter. It colours, in the same manner, the water and the shells of these oysters; and it would not be impossible to find some tinged directly by this matter, without any animalcules having penetrated into them. It is so difficult to render observations of this kind complete, and one may always so easily suppose an anterior state, still more attenuated, and which may have escaped every microscope, or invisible germs, which the necessity of the concurrence of air prevents from separating, that many philosophers will probably refuse to admit

* M. Mertens, a botanist of Bremen, has observed similar facts on the *Conferva mutabilis*. On the 3d August, he says, it was in its vegetable state; on the 5th it resolved itself into molecules possessed of mobility; on the 6th some of these molecules united into simple articulations; and, on the 11th, it was restored to its original form.

the consequences, which the author would draw from these facts, for attributing to matter a general disposition to become organised, which would be independent of the ordinary mode of generation.—*Mem. de l'Acad. Roy. des. Sc.* t. vi. p. cxxi.

24. *On the Animalcules that colour Oysters Green.*—M. Gaillon has sent new observations on the animalcules which colour oysters, and which, after M. Bory de St Vincent, he names *Navicules vertes.* He has remarked other species, which also penetrate into the substance of the oyster, and give it different colours, rendering it grey, brown, or yellowish. Among these are the *Vibrio bipunctatus,* and *tripunctatus* of Muller. It is remarkable, that the green navicule does not exist in the waters of the sea, nor even in the fresh water of the neighbourhood of Dieppe. It only multiplies, in a certain degree, of saltness and stagnation of the water, such as is known to produce it in the *parcs,* where the colouring in question is produced. M. Gaillon, however, has seen some that issued from a conferva of the genus *Vaucheria* found in fresh water about Evreux.

25. *Beaver.*—The beaver of Europe M. Cuvier is now disposed to consider as specifically distinguished from that of Canada, by the form of its head. Viewed in profile, instead of presenting a nearly uniform curve from the occipital bone to the end of the *ossa narium,* its outline is almost straight, being inflected only towards its middle, its sagittal and occipital project strongly, the zygomatic arch is broad, and much depressed, the whole cerebral portion is considerably elongated backwards, and the nasal bones advance far beyond the orbitar process of the os frontis. These parts are obviously less developed in the American beaver, which also appears to be one-sixth smaller at the same age than the living European one now in the Jardin du Roi. In their habits there appears to be less to distinguish them than has hitherto been supposed. The European species evinces the same aptitude and ability in constructing a habitation as are exhibited by the beaver of Canada, anecdotes in proof of which are given by M. F. Cuvier *(Zoological Journal).* On these observations by M. F. Cuvier, we would observe, that, on comparing the skull of a Canadian beaver with the very fine specimen which was dug up some years ago in Scotland, and which, in all probability, belonged to an individual of the European variety

or species of beaver, the differences pointed out by M. Cuvier can scarcely be said to exist. *1st*, The skull is considerably larger than the Canadian variety; but this is not any specific difference. *2d*, The profiles very nearly correspond. *3d*, The sagittal crest is strongest in the Canadian skull; the occipital strongest in the Scottish. *4th*, The nasal bones differ considerably, and the observation of M. Cuvier is quite correct in this respect.—R. Knox.

26. *On the Culture of Bees in Forests, by* M. Buttner.—It has been a custom in Livonia, from time immemorial, to make cavities in the trees of a forest, for the purpose of receiving and rearing the swarms of bees. Some of the proprietors have hundreds, and even thousands, of bee trees. Those which are chosen for this purpose are large oaks, firs, pines, alders, &c. It has been objected to this system, that it destroys the forests and diminishes the quantity of building wood, but M. Buttner observes, that it is not necessary to choose the finest trunks, and that stunted trees are equally serviceable for this purpose, if they have sufficient size He states also, that a bee tree is worth more than if sold for wood, that the old hollow trees, which will serve for an age or two, spread seed around, and cause the production of young seedlings, which would be obtained with difficulty, by destroying the old trunks. He adds, that the pure air of the higher regions agrees better with the bees than the air inclosed in hives, which receive the exhalations of the earth, and in which contagious diseases sometimes make great ravages. The proof he offers is, that, when garden bees swarm, they are directed instinctively towards the woods, whilst the bees of the wood never swarm towards the gardens.—*Bull. Univ.* D. vii. 34.

27. *Peculiar Cases of the Use of Milk as Food.*—The giraffe which was sent to the king of France by the Pacha of Egypt, was observed never to drink the smallest quantity of water, but only milk. This odd circumstance is explained by the person who describes its habits and manners, as resulting from the circumstance, that, being taken whilst young, it was, probably, supplied with milk, which, not having been discontinued, has occasioned this permanent inclination in the animal. It appears very probable, that animals which drink but little naturally, will not drink water, if a sufficient quantity of milk be supplied

to them. Milk was offered to the young asses which had been separated from their dam for some time, and they drank it with pleasure. It was then offered to a young mule, and to a horse five years of age, both drank of it. Being offered to a monkey, it seemed never to have taken enough. Pigs, dogs, cats, and rats, drink milk with avidity. "I will quote, on this occasion, a curious fact, but little known, that of a goat, which sucked itself, and which was, with difficulty, broken off this bad habit." Now, as there are so many animals which are fond of milk, without having preserved the habit of drinking it, it will not seem surprising that the giraffe, a herbivorous animal, which has been continually supplied with this drink, should prefer it to all others. —*Mem. du Museum*, xiv. p. 74.

28. *On the predestination of the Sex;* by M. Hufeland.—In a memoir printed in his Medical Journal, in 1819, M. Hufeland shewed that the numerical relation of the individuals of the two sexes in man (21 . 20) is the same over the whole surface of the globe, that this relation does not depend either upon climate or planetary influences, or upon the generative act, but that the sexual difference already exists in the germ formed beforehand in the mother, and that the fecundating principle has only to give animation to it. To the recent inquiries made in France, by MM. Olivier, Prevost, Dumas, and Girou de Buzareingue, and the conclusions which they have elicited, M. Hufeland opposes several objections, viz. 1*st*, The sexual union of a middle aged man with a younger woman, being, for very natural reasons, the most frequent of all, there ought to result a very great excess of male children, which, however, is by no means the case; 2*d*, In long wars, where the class of young men is nearly exhausted in a nation, a marked excess ought to manifest itself on the side of the female sex, which, however, is never observed; 3*d*, The conjugal unions in which the parties are of equal age, ought to produce an equal number of male and female descendants, through the whole duration of life, which is not the case. 4*th*, Experience shews conjugal unions of middle aged men with young women, by which, however, there have been only female children; 5*th*, Even allowing all the combinations established upon the influence of the relative age of the father and mother, they are not sufficient to explain the constant relation of 21 : 20

between the sexes. The same objections may also be made to the influence attributed to the relative power of the constitution of the male and female, which has been estimated for the purpose of levelling the exceptions. With regard to experiments upon animals, it is clear that they are inapplicable to man. The numerical relation between the two sexes does not depend upon accidental circumstances, but is founded upon a superior law of nature, constant in all climates, and at every period of time, and always the same in all its relations

29. *Growth and Habits of a Young Rhinoceros*.—The first dimensions taken of the animal were made at three days old, when it measured two feet in height, three feet four inches and three quarters in length, and four feet and seven-fourths of an inch in its greatest circumference. Since that, it has increased in the following proportions. From three days to one month it gained five inches in height, five inches and three quarters in length, and three inches and three quarters in circumference; while, from the age of one to fourteen months, it increased one foot seven inches in height, two feet in length, and two feet seven inches in circumference. From fourteen to nineteen months, four inches in height, one foot four inches and a half in length, and two feet four inches in circumference,—the rhinoceros being, at the date of the last measurement, in December 1825, four feet four inches high, seven feet four inches and a half long, and nine feet five inches in circumference. The general aspect of the cub now resembles the mother, the heavy folds of the skin, which were wanting in July, being fully formed in December. The nasal horn, at the latter period, scarcely protruded two inches beyond the skin. The observations made by Mr Hodgson, surveyor-general of India, are of great value, in reference to all questions respecting the rate of developement and full growth of many of the larger animals, respecting which scarcely any authentic statements are to be found in authors, although they have exercised the genius of Buffon, and other philosophical writers. The diminished ratio of increase of height, remarkable in the later period of developement, as stated by Mr Hodgson, renders it probable that the animal will yet be a long time in arriving at its adult size,—a supposition which is also rendered probable by its seventeen months' gestation, and the slow growth

of its horn. Mr Hodgson, in pursuing his inquiries, has had reason to remark the amiableness of the young animal's disposition, both towards his keeper and strangers; an instance, he observes, of the power possessed by Asiatics, through their tranquil familiarity of taming the most formidable quadrupeds. That the rhinoceros will submit to the domesticating influence of man, we have seen more than one instance; nor would the tractability of this herbivorous animal seem in any way a matter of surprise, when we know that the fiercest of the carnivorous tribe have become the attached companions of their master, if the rhinoceros had not been held up by writers of every age and country as a standard of brutality and untameable fury. India exhibits numerous proofs of false conclusions by natural historians regarding the habits and temper of animals, and affords a field of interesting inquiry respecting their instinct, as contradistinguished to what might be called their educatable faculties. This subject has hitherto, we believe, only been treated by the naturalists of Europe, who have relied, in many cases, upon very vague or insufficient narratives, but never by any person residing in the native country of the animals whose history has been recorded.

30. *Cuvier's Great Work on the Natural History of Fishes.*—This very important work, in which Cuvier and Valenciennes have been so long engaged, and which will contain descriptions of five thousand species of living and fossil fishes, is now in the press, and will soon appear.

31. *A New Species of Pentacrinus discovered in the West Indies.*—We are informed that a naturalist of St Vincent's, we presume Mr Lansdown Guilding, has found in the Caribbean Sea, a new species of this tribe. This fact is the more interesting, when viewed in connection with the discovery of a British species, described by Mr Thomson in his memoir, noticed in the present number of this Journal.

PHYSIOLOGY.

32. *Distribution of Nerves in Muscular Fibres.*—In a memoir on muscular action, MM. Dumas and Prevost have communicated some very interesting microscopical observations on the distribution of the nerves in the muscular fibres, and on the forms which these latter assume during their contractions. They

placed a thin piece of muscle, retaining its nerves, under the microscope, and made it contract by means of galvanism. The fibres contracted by bending in a zigzag manner, and the last nervous filaments were seen to proceed parallel to each other from the branch giving origin to them, to be inserted precisely at the points where the fibres form their angles.

ANATOMY.

33. *Sabulous Formation in the Brain.*—Dr Bergmann of Celle, in a memoir transmitted to the Royal Society of Gottengen, gives an account of twenty cases of earthy granulations occurring in the plexus choroides of the lateral ventricles of the brains of insane persons. These earthy granulations resemble those of the pineal gland. Mr Stromeyer examined both varieties, and found their constitution similar, and of the following nature: Phosphat of lime in large quantity, phosphat of magnesia in small proportion, traces of carbonate of lime, and an animal substance of an albuminous nature.—*Bullet. Univ.* c. x, p. 128.

ARTS.

34. *Water Works of the Ancient Romans.*—It is an erroneous, but at the same time a prevailing opinion, that the ancient Romans were unacquainted with some of the simplest laws of the motion and pressure of water. This is, however, unfounded, as Pliny informs us, as a general principle, viz. that water, conducted in pipes or tubes, will always rise to the same height with the fountain from which it flows. The water was conducted by the Romans into their buildings, either by channels constructed of masonry, or by means of wooden pipes, or even of earthen ware; and allowed a descent of one foot in sixty for the flow of water, which was admitted into a reservoir, divided into three equal compartments, after it had been brought within the walls of the city; one to supply the pools and fountains, a second for the baths, and a third for the palaces and private houses. The pipes used by them were of lead, about ten feet long, seven inches and a half in the bore, and a quarter of an inch thick *. However, they were very averse to the use of

* Specimens of Roman leaden pipes are preserved in the Museum of Natural Philosophy in the University.

leaden pipes, knowing them to be of an unwholesome nature. They were made of thin plates of lead, bent in the form of a cylinder, and soldered at the edges: casting, as practised at present, was unknown. The supply of water was regulated by the dimensions of the spouts; these were of twenty-five descriptions. The standard spout seems to have been about nine-tenths of an inch in the bore, and its length about eight inches and seven-tenths; and, if that was also the height of the column of water, 1970 cubic feet would be discharged in the space of twenty-four hours.

35. *Manner of Bronzing Statues, Medals, and Ornaments, made of Copper or Bronze.*—The receipts for communicating to newly cast bronze a colour which gives it the appearance of old bronze, vary more or less. We shall here give the method employed by Jacob, one of the best artists of Paris. Take two gross of sal ammoniac, half a gross of salt of sorrel, which dissolve in a demi-setier (100 grammes) of white vinegar: after cleaning the metal well, dip a pencil slightly in the solution, and rub it continually on the same place, until the colour is dry, and the tint has acquired the desired intensity. That the drying may take place more quickly, this operation is performed by exposing the object to the sun or in a stove. The bronze colour becomes deeper, in proportion to the length of time occupied in passing the brush over the same place.—*Journ. des Connaiss. Usuel et Pratiq.* n. 27. t. v. 1827.

36. *Loss of Gold and Silver in Gilding and Plating.*—Fifty thousand pounds worth of gold and silver are said to be annually employed at Birmingham in gilding and plating, and which is therefore for ever lost as bullion.

37. *Piney Tallow.*—Piney tallow is a vegetable product, which resembles common tallow in many of its properties. It is obtained from the piney tree (Vaterica Indica), by boiling the fruit in water, when the tallow is soon found to rise to the top in a melted state, and, on cooling, forms a solid cake. The colour of the tallow is generally white, but sometimes yellow; it is greasy to the touch, with some degree of waxyness; it is almost tasteless, and has an agreeable odour. It melts at a temperature of 97½° and consequently remains solid in the climate of India. The piney tallow is used only for medicinal purposes at Mangalore, but the tree is common throughout the

western coast of the peninsula of India, at least as far northward as the boundaries of the province of Canara; and there would no doubt be sufficient to supply a considerable demand for this valuable product. The piney tallow has been made known in this country by Dr Babington, according to whose analysis 100 parts contain carbon 77, hydrogen $12\frac{1}{2}$, oxygen $10\frac{2}{3}$, = 100.—*London Mechanics' Register.*

38. *Indelible Writing Ink.*—The following, recommended as a process for preparing indelible writing ink, or at least as a sort of approximation to it, is copied from the last number of the Royal Institution Journal. "Let a saturated solution of indigo and madder in boiling water be made in such proportion as to give a purple tint; add to it from one-sixth to one-eighth of its weight of sulphuric acid, according to the thickness and strength of the paper to be used. This makes an ink which flows pretty freely from the pen; and when writing which has been executed with it is exposed to a considerable but gradual heat from the fire, it becomes completely black, the letters being burnt in and charred by the action of the sulphuric acid. If the acid has not been used in sufficient quantity to destroy the texture of the paper, and reduce it to the state of tinder, the colour may be discharged by the oxymuriatic and oxalic acids and their compounds, though not without great difficulty. When the full proportion of acid has been employed, a little crumpling and rubbing of the paper reduces the carbonaceous matter of the letters to powder, but by putting a black ground behind them they may be preserved; and thus a species of indelible writing ink is procured (for the letters are, in a manner, stamped out of the paper), which might be useful for some purposes, perhaps for the signature of bank notes."

39. *Lardner's Lectures on the Steam-Engine.*—A short series of popular lectures on the steam-engine, by Dr Lardner, the Professor of Mechanical Philosophy in the London College, is announced for publication. The author professes to have treated the subject in the most familiar style, and to have stripped it so far of mathematical reasoning and technical phraseology, as to render it at once intelligible and interesting to the general reader.

40. *Carter's Patent Cast-Iron Roofing.*—Carter's patent cast-iron roofing is represented by the patentee as well adapted for

covering public buildings, private dwellings, and warehouses. The expence of this cast-iron roof, compared with one of lead, including deductions for the want of close boarding, which is indispensable for a lead covering, is quoted at not more than one-third of the expence of a leaden roof. At the Toll-end furnaces in Staffordshire, the expence of these cast-iron plates is stated at L. 11, 10s. per ton, and the freight to London at L. 1, 10s., and about one-third less to Bristol, Liverpool, and Hull. It is also said, that, owing to these plates being small, and loosely fitted together, they are less subject to fracture from changes of temperature than lead, which is frequently confined, and does not allow room for the contraction and expansion occasioned by changes of temperature. A slate roof is estimated by the patentee to last about fifty years, while, in that time, the iron would scarcely be deteriorated; and in case, he adds, of destruction of a building by fire, the old iron will be worth nearly half of its original cost. A square of 100 feet of these plates is estimated to weigh 1000 lb., while the same one of copper roofing weighs, according to Tredgold, 100 lb. of lead, 800 lb. of large slates, 1120 lb. of ordinary slates, 900 lb. to 500 lb., and of pan tiles 1780 lb. to 650 lb. It is particularly suited, in point of taste, to the Grecian style of architecture, inasmuch as it requires to be laid at a less angle than is common with any other metallic covering. The effect also produced by the simple and regular form of the parts composing this covering, is said to be pleasing; and the eye is relieved by the lights and shades which arise from the alternate projection, the apparent thickness, and from the gradation of the plates. The patentee recommends that the plates be three-sixteenths of an inch in thickness, and that they be cast in squares of two feet, with flanges of two inches in depth. The weight of these plates will be about 10 lb. per square foot; and he conceives that this roof will require no fastening, but that their weight and particular construction will secure them against the effects of high winds. But should any one be doubtful of this, he proposes to cast a loop in the under side of each plate of the raised row of plates, by which they may be hooked or chained down to the rafters. It must be obvious that the raised rows would effectually secure the sunk ones in their places. This contrivance we consider as ingenious,

and the application of the plates to be extremely simple; but the roof should be more substantially fixed to the rafter than is proposed by the patentee. Upon making a model of these plates, there appears to be a want of *cover* at every angular junction of four plates, by which an opening, whose area will depend upon the nicety with which the plates are fitted, is left at each end of the upper edge of the plates of the sunk row. At this junction, some additional *cover* seems necessary to ensure a water-tight roof. Perhaps, for our climate, the flanges of these plates should be three or four, instead of two inches deep, as in coverings a *drip* of even *three* is found to be small enough. The price of old iron seems also to be overrated, at least it seldom, in Scotland, brings more than a one-fifth of its original value. With regard to the period assigned for the duration of slates, it may be mentioned, that, for good slates, even 100 years would be considered as a safe calculation. Upon the whole, we are of opinion that it would be well to practise this mode of roofing upon sheds and other temporary erections, until experience shall have shewn it to be an efficient water-tight covering.

STATISTICS AND GEOGRAPHY

41. *Civilization of the Aborigines of Newfoundland.*—Our active and enterprising friend Mr W. E. Cormack, whose interesting journey across Newfoundland appeared in a former Number of the Journal, is about to embark in another undertaking, which will, we hope, prove successful. He writes to us as follows: "*Exploits, Newfoundland, October* 27. 1827.—I have been looking forward to communicate with you on the condition of the Bæothicks or Red Indians, the aborigines of Newfoundland. I am here with three Indians,—a Micmack, a mountaineer, and a Bennakee (Canadian),—equipped and ready to set off into the interior, in search of some of the *Bæothicks*, to endeavour to obtain a friendly interview with them, as a step to commence bringing about their civilization. I leave the sea-coast to-morrow, and intend to devote a month in traversing those parts of the country where they are most likely to be met with. The season of the year will not admit my traversing every place where they may be found, but I expect to come up with some of their encampments within a month hence. Government made

one vain attempt to reconcile this tribe to the approaches of civilization about sixteen years ago; but to civilize a long persecuted tribe of savages requires repeated attempts of this kind.

42. *Captain Parry's reported Second Expedition to the North Pole.*—Although it has been generally believed that Captain Parry was next season to resume his attempt in reaching the North Pole, we can assure our readers that no such plan ever was entertained by the Admiralty. The report may have originated in Captain Franklin's having expressed a wish to be allowed (by means of a ship sent by Bering's Strait), to finish the very small portion of the north coast now remaining unexamined; and, at the same time, a similar patch on the Asiatic side, respecting which a doubt has hitherto existed. But we are informed there will certainly be nothing undertaken until Captain Beechy's return with the Blossom.

NEW PUBLICATIONS

1. *Introduction to Comparative Anatomy.* By Professor CARUS of Dresden. Translated from the German by R. T GORE, Esq. 2 vols. 8vo, with a Quarto Volume of Plates. Longman & Co. London, 1827.

NOTWITHSTANDING the number of contributors to comparative anatomy in this country, it is somewhat remarkable that the translations of Blumenbach, Cuvier, and Carus, are almost the only elementary works on this highly interesting and useful branch of science, which exist in the English language. Professor Carus, the author of the manual now before us, was formerly teacher of the science at Leipsic; he has travelled and examined animals, both in their recent state, and prepared in museums, particularly in the extensive museum of comparative anatomy under the care of Rudolphi at Berlin, and he is the author of various memoirs and treatises on this subject. The splendid illustrations of comparative anatomy, now publishing at Leipsic, in large folio fasciculi, is the production of Carus, and most of the plates of that work are drawn by him from nature; but his reputation is chiefly founded on his recent im-

portant discoveries of the circulation of the blood in different orders of insects. His present elementary work contains a comprehensive sketch of the actual state of the science, and the materials are arranged according to new and peculiar views. In place of commencing with the most complex animals, and examining their structure in a descending series, as is usually done, he has traced the gradual and successive developement of the different organs of the body, from their first and simplest appearance in the lower classes, to their most complex and perfect forms in the higher orders of animals. By keeping constantly in view the functions of animals, and the modifications which entire systems of organs present in the different classes, he has rendered this work a highly interesting and useful introduction to comparative physiology. The treatise commences with a methodical list of the principal works and memoirs which have appeared on this subject up to the present time, and although the limits of this compilation have prevented the author from tracing the progress of discovery in any department of the science, the deficiency of his references is amply supplied by the numerous notes and extracts of his judicious and intelligent translator. Mr Gore, who is likewise the translator of Blumenbach's Natural History, has added to his translation of Carus copious extracts from the works of Rudolphi, Meckel, Teidemann, Blumenbach, Reil, Weber, Spix, Camper, Soemmering, Geoffroy, Desmoulins, Cuvier, De Serres, Blainville, Home, and almost every other continental or British authority, which render it greatly superior to the original as a work of reference. The accompanying plates contain 330 figures, which are executed on a small scale, to adapt them for more general circulation. Two hundred of these figures were drawn by Carus from nature; the rest are selected from Trembley, Cavolini, Spix, Gaede, Teidemann, Cuvier, Swammerdam, Scarpa, Rudolphi, Rosenthal, Herold, Treviranus, Geoffroy, Arsaky, Meyer, Mery, Emmert, Nitzsch, Blumenbach, Daubenton, Fisher, Albers, Kieser, Wolff, Hunter, Home, Macartney, and Carlisle. In the table of classification, and throughout the work, Professor Carus has adopted a new arrangement of the animal kingdom, modified from the Regne Animal of Cuvier, by the author's own researches concerning the structure of insects. From the

discovery of the circulation in certain neuropterous, coleopterous, dipterous, and orthopterous insects, and from the extent of respiration in this class, he has placed them, along with the Crustacea and Vermes, at the head of invertebrate animals, as possessing a more complicated and perfect organization than the mollusca. By this arrangement it follows that the Planaria, the Thalassima, the Tænia, and even the Hydatis, are more perfect animals than the Sepia, the Loligo, and the Octopus. Although the existence of a circulation in insects does not warrant conclusions so extraordinary, it is a highly interesting fact, and shews a further analogy between them and the Crustacea, in which it has been long known to exist. The first volume of the work is devoted to the consideration of the organs of animal life, including the nervous system, and the organs of sense and motion, which are examined first in invertebrate animals, from zoophytes to insects, and then in the four classes which possess a skeleton with brain and spinal marrow. The second volume treats of the organs of organic (or vegetative) life, including those of digestion, respiration, secretion, circulation, and reproduction, which are examined in the same order, from the lowest animals upwards to the most perfect. This mode of considering animals in an ascending scale, appears the most natural, as it leads us from simple to more complex objects, it is the order of their creation, as pointed out by their fossil remains, by sacred testimony, and by all the phenomena of organized bodies, and it is the arrangement so admirably developed in the system of Lamarck. Notwithstanding occasional errors, inseparable from a work which embraces the structure of all existing animals, we consider this treatise of Professor Carus as a valuable contribution to comparative anatomy, and the translation by Mr Gore, as an excellent outline of the present state of the science, calculated to serve as a work of reference, and to supply a great desideratum in our language.

2. *Conversations on the Animal Economy.* By a Physician; in Two Volumes 8vo. Longman & Co. 1827.

Mrs Marcet's admirable Conversations on Chemistry, Natural Philosophy, and Political Economy, are well known, and much esteemed by the public. The present volumes are in imi-

tation of that accomplished lady's writings. The author, in our opinion, has succeeded in producing for the instruction of the general reader, and even the learned, an accurate, interesting, and highly amusing account of the animal economy.

3. *Memoir on the Pentacrinus europæus; a recent Species discovered in the Cave of Cork, July* 1. 1823; *with Two illustrative Plates.* By JOHN V. THOMPSON, Esq. F. L. S., Surgeon to the Forces. King and Ridings, Cork; and Treuttel and Wurtz, London. 1827.

UNTIL the publication of this valuable memoir, naturalists were acquainted with only one living species of this very rare and curious tribe of invertebrate animals. The *P. europæus*, described by Mr Thompson, is about three quarters of an inch in height, slender in proportion, and has been hitherto found attached to the various species of *Sertularia* and *Flustra*, which occur in the deeper parts of the harbour of Cork, viz. in from eight to ten fathoms. He is of opinion, and we think he is right, that the Pentacrinus is a stipitate Asterias, most nearly allied to the genus *Comatula*. The remarks in the memoir, in reference to the fossil animals of this group, are deserving the attention of the geologist; and the neatly executed accompanying plates add to the value of these and other observations of our author. We are happy to find Mr Thompson is about to publish, in a series of numbers, accompanied with figures, a work, entitled, "Zoological Researches and Illustrations;" which, judging from the present memoir, promises to add much to our knowledge of the natural history of the tribes of animals to which Mr Thompson has devoted his attention.

4. *Anatomical Description of the Human Eye.* By ALEXANDER WATSON, Fellow of the Royal College of Surgeons, &c. Illustrated by a Coloured Plate. Maclachlan and Stewart, Edinburgh. 1827.

THE description of the human eye in this memoir is accurately and neatly executed. The accompanying coloured plate contains a series of views, illustrative of the structure of the eye, drawn with great accuracy, and beautifully coloured. This little work will be useful to the student of anatomy and surgery;

and we can safely recommend it to the student of natural history, and also to those interested in natural philosophy.

Forthcoming Transactions of Foreign Societies.

The Helvetic Natural History Society, at their meeting in August last, decreed that their Memoirs should be printed. The first volume is at present in the press; and, besides many interesting memoirs, contains an important paper by De Lusser of Altdorf, on the Suite of Formations extending from St Gothard to the Mollasse.

A second volume of the *New Alpina*, an interesting Swiss work, has just appeared: it contains many zoological and two mineralogical papers.

De Caumont, Secretary to the Linnean Society of Calvados, announces a third volume of the Memoirs of the Linnean Society of Calvados, with Geological Maps of that country, and Memoirs of Desnoyers, Marcel de Serres, and Prevost. He has taken charge of printing the Memoirs, and as he is rich and active, he cannot fail to be useful to the sciences.

Ferussac intends still farther to enlarge the plan of his excellent *Bulletin*, so that it may flourish after his death. The activity of this man is truly wonderful, when we recollect that he was shot through the chest during the Spanish war, and is labouring under the effects of that nearly fatal accident.

List of Patents granted in England from 17th August to 20th November 1827.

1827,

Aug. 17. To Lemuel Wellman Wright of Mansfield Street, Borough Road, Surrey, for improvements in the construction of Cranes.

21. To Lemuel Wellman Wright of Mansfield Street, Borough Road, Surrey, for improvements in machinery for Cutting Tobacco.

To Gabriel de Serras of Leicester Square, Stacey Wise, and Charles Wise, of Maidstone, paper-makers, for certain improvements communicated from abroad, in Sizing, Glazing, or beautifying the materials employed in the manufacturing of paper, paste-board, Bristol-boards, &c.

Aug. 30. To JOHN HAGUE of Cable Street, Wellclose Square, for a new method of working Cranes or Tilt Hammers.

To B. M. COMBS of Birmingham, for certain improvements on, or additions to, a Pulley Machinery, and apparatus used for securing, fixing, and moving curtains, and roller and other blinds.

To WILLIAM DELTMER of Upper Mary-le-Bonne Street, Fitzroy Square, pianoforte-maker, for improvements on Pianofortes.

Sept. 6. To WILLIAM J. FORD of Mildenhall, farrier, Suffolk, for improvements in the make, use, and application of Bridle-bits.

To GEORGE CLYMER of Finsbury Street, for an improvement in Typographic Printing between plain or flat surfaces.

Oct. 11. To JOSEPH HALL and THOMAS HALL of Leeds, for an improvement in the making of Metallic Blocks for drawing off liquids.

To ELIAS CARTER of Exeter, for a new covering for the Roofs of Houses, &c.

To JOSHUA HORTON of West Bromwick, boiler-maker, for a new method of forming and making of Hollow Cylinders, Guns, Ordnance. Retorts, and various other hollow and useful articles in Wrought-Iron, in Steel, or composed of both these metals.

To GOLDSWORTHY GURNEY of Argyle Street, Hanover Square, surgeon, for improvements in Locomotive Engines, and other apparatus connected therewith.

To JAMES STOKES of Cornhill, London, for improvements in making, boiling, burning, clarifying, or preparing Raw or Muscovado bastard Sugar and Molasses.

To JOHN WRIGHT of Princes Street, Leicester Square, for improvements in Window Sashes.

Nov. 6. To JAMES SMETHURST of New Bond Street, for an improvement upon Lamps.

To FREDERICK FOVEAUX WEISS of the Strand, surgeon's-instrument-maker, for improvements in the construction of Spurs.

8. To JAMES WHITE of Paradise Street, Lambeth, engineer, for a machine or apparatus for filtering, which he denominates an Artificial Spring.

10. To JOHN PLATT of Salford, near Manchester, fustian-dresser, for certain improvements in machinery for Combing Wool, and other fibrous materials; communicated from abroad.

To WILLIAM COLLIER of Salford, fustian-shearer, for certain improvements in the Power-Loom for weaving; communicated from abroad.

17. To JOHN WALKER of Weymouth Street, Mary-le-Bonne, Esquire, for an improved Castor for furniture.

To HENRY PINKUS of Philadelphia, for an improved method of Purifying Carburetted Hydrogen Gas for the purpose of illumination

20. To SAMUEL SEVILL of Brownshill, in the parish of Bisley, Gloucestershire, clothier, for his himprovements applicable to raising the Pile, and dressing Woollen and other Cloths.

List of Patents granted in Scotland from 3d October to 6th December 1827.

1827,

Oct. 3. To PETER BURT of Waterloo Place, in the parish of St Ann, Limehouse, in the county of Middlesex, mathematical instrument-maker, (in consequence of a communication made to him by a certain foreigner residing abroad) for "an improvement on Steam-Engines."

24. To JOSHUA HORTON of West Bromwick, in the county of Stafford, boiler-maker, for "a new and improved method of forming and making of hollow Cylinders, Guns, Ordnance, Retorts, and various other hollow and useful articles in wrought-iron, in steel, or composed of both of these metals."

Nov. 2. To SAMUEL PRATT of New Bond Street, in the parish of St George, Hanover Square, in the county of Middlesex, camp equipage-manufacturer, for "certain improvements in Bedsteads, Beds, Couches, and other articles of furniture, principally designed to be used on shipboard."

To THOMAS BREIDENBACH of Birmingham, in the county of Warwick, merchant, one of those designed Quakers, for "certain improvements on Bedsteads, and in the making manufacturing or forming articles to be applied to or used in various ways with bedsteads, from a material or materials hitherto unused for such purpose."

22. To WILLIAM FAWCETT of Liverpool, in the county of Lancaster, engineer, and MATTHEW CLARK of the island of Jamaica, engineer, for "an improved apparatus for the better manufacture of Sugar from the Canes."

28. To BENNET WOODCROFT of Manchester, in the county of Lancaster, manufacturer, for "certain processes and apparatus for printing and preparing for manufacture Yarns of Linen, Cotton, Silk, Woollen, or any other fibrous material."

29. To LEMUEL WELLMANN WRIGHT of Mansfield Street, Borough Road, in the county of Surrey, engineer, for "certain improvements in the combination and arrangement of Mechanical Powers, applicable to the purposes of driving machinery, and lifting and moving heavy bodies."

29. To LEMUEL WELLMAN WRIGHT of Mansfield Street, Borough Road, in the county of Surrey, engineer, for "certain improvements in the combination and arrangement of machinery for making Metal Screws."

Dec. 6. To JOSHUA JENOUR *junior* of Brighton Street, in the parish of St Pancras, in the county of Middlesex, gentleman, for "a Cartridge or Case, and Method of more advantageously inclosing therein, shot or other missiles, for the purpose of loading fire-arms and guns of different descriptions."

THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

Biographical Memoir of Peter Simon Pallas, *Counsellor of State to his Imperial Majesty of all the Russias.* By Baron Cuvier, Knight, Professor, &c.

When a man has devoted his whole life to science, when, being occupied solely in observing and writing, he has only intermitted his researches during the time necessary for their publication,—it might be expected that his career would not be marked by any remarkable incident, and that the analysis of his works would, in a manner, present the history of his life. But if, labouring only for those engaged in the same pursuits, he disdained to render his writings attractive to others; if, with the view of presenting the greatest number of facts in the shortest space, he uniformly stated them in the simplest manner, and left to others the easy merit of deducing their results; this very analysis becomes a matter of extreme difficulty, and to give any distinct conception of his works, it would be necessary to transcribe them.

Such was Pallas. Separated in his youth from his family and country, a third of his life was passed in the deserts, and the rest in his cabinet; and in both situations he made a prodigious number of observations, and produced a multitude of memoirs and volumes. The whole of his writings, though destitute of embellishment, are full of novelties and truths; they have placed the name of their author in the first rank among naturalists, who are continually turning them over, and quoting

them in every page; they are received and consulted, with equal interest, by historians and geographers, by those who study the philosophy of languages, and the character of nations. But it is precisely this multiplicity and this diversity of his labours that obliges me, at present, to reduce his eulogium almost to a mere table of contents, which it would be impossible for me even to read in full, and for which I entreat, beforehand, the indulgence of my auditors.

Peter Simon Pallas, Counsellor of State of the Emperor of Russia, Knight of the order of St Volodimir, member of the Academies of Science of Petersburg, London, Berlin, and Stockholm, and Foreign Associate of the Institute of France, was born at Berlin on the 22d September 1741. His father was Simon Pallas, Professor of Surgery in the University of Berlin, and his mother, Susanne Leonard, who was of French extraction, but born in the Colony of French Refugees established at Berlin.

Being destined by his father for the medical profession, he was, at an early age, instructed in various languages, and made such rapid progress, as, in a short period, to be able to write, with nearly equal facility, in Latin, French, English and German. This faculty, which is more easily acquired in youth, will, without doubt, every day become more general, more especially as the sciences have ceased to possess a common language, and as there is not a single great empire in Europe in which several are not spoken. It cost so little trouble to the young Pallas, that he was always at the head of his companions in their other studies, and, not content with what his masters assigned him, he occupied his leisure hours in Natural History, and with so much success, that, at the age of fifteen, he sketched ingenious divisions of several classes of animals.

After attending the lectures of Gleditsch, Meckel and Roloff at Berlin, and of Rœderer and Vogel at Gottingen, he went to Leyden to finish his medical studies under Albinus, Gaubius and Muschenbroeck.

At this period, the possession of numerous colonies in both Indies, and the command of the commerce of the world, for two centuries, had accumulated in the Dutch collections the rarest

productions of nature; and the taste for natural history, for which the mother of the last stadtholder was so much distinguished, gave a new impulse to its study.

With the decided predilection which Pallas brought with him into such a country, it was impossible that his ardour for that science should not be increased. A voyage to England still farther strengthened and increased it, and, having formed the resolution of making it henceforth the occupation of his life, he solicited his father's permission to settle at the Hague.

It was there that he published, in 1766, *Elenchus Zoophytorum*, or table of zoophytes, the first of his great works. Five-and-twenty years before this time, corals had been generally considered as plants; and the discovery which Peyssonnel made of their animal nature appeared to Reáumur so paradoxical, that, in publicly mentioning it, he did not venture to name its author. But, shortly afterwards, the more astonishing discoveries of Trembley, regarding the divisibility of the polypus, and the detailed observations of Bernard de Jussieu and Ellis, on the corallines of our shores, dispelled every doubt on the subject. With the consent of all naturalists, an entire order of organised beings passed from one kingdom to another: Linnæus inscribed them among the animals; the young Pallas undertook to arrange them, and draw up their catalogue. The Dutch collections furnished him with a rich harvest of them, which he arranged with a rare degree of sagacity. The preciseness of his descriptions, and the care with which he referred the synonyms of other authors to his species, were very remarkable in an author of only twenty-five years of age. His introduction was still more so. He rejected the old division of natural objects into three kingdoms, and shewed that plants have not marked classes like animals, insomuch that they are only, so to speak, one of the classes of the great organic kingdom, as quadrupeds, fishes, and insects severally are; a truth with which our botanists seem scarcely impressed at the present day. In maintaining this approximation of the two kingdoms, he did not, however, also adopt the single scale of beings, which the genius of Bonnet had rendered so popular; on the contrary, he presented the tree of organisation as producing a multitude of lateral branches, which it would be impossible to arrange in linear continuity, without doing violence to nature.

With regard to corals, in particular, he shewed the error of the definition which was then almost generally received, as if they were hives of polypi; he demonstrated their trunk to be itself a living substance, a sort of animal tree with several branches and heads; a compound animal, the stony part of which is only the common skeleton, which grows at the same time as the individual animals, but is not fabricated by them. Linnæus was the first to support these bold ideas, which are now universally received *.

The *Miscellanea Zoologica*, which Pallas published the same year as his *Elenchus*, added still more to his reputation. So young an author was seen with astonishment, uniting in himself all the merits of the great masters who then divided among them the empire of science; boldly assuming as his models the great French naturalist and his fellow-labourer Daubenton; taking upon himself their conjoined labour, and, without allowing himself to be swayed by their authority, combining, with the profound sagacity of the one, and the patient accuracy of the other, those methodical and strict views condemned by both.

But what would have excited still more astonishment, had the public mind at this period been capable of estimating it, was the sudden light which he threw upon the least known classes of the animal kingdom, those which were confounded under the common name of Worms. Not allowing himself to be imposed upon by the errors of Linnæus, any more than by those of Buffon, he shewed that the presence or absence of a shell cannot afford the true basis of their distribution, but that the analogy of their structure ought to be first consulted; that, in this respect, the ascidiæ, and not the tethyses, as Linnæus imagined, are the true analogies of the bivalves; that the teredo, as Adanson had already shewn, ought also to be united with them; that the univalves, on the contrary, are more allied to the slugs, the dorises and scyllææ; lastly, that the aphroditæ, of the anatomy of which he at the same time gave an excellent account, ought to be placed near the nereides, the serpulæ, and other articulated vermes, whether these possessed shells or not.

* The *Elenchus Zoophytorum* has been translated into Dutch by Boddart, and into German by Wilkens. Herbst has published the latter translation with additions and plates. Nuremberg, 1787, 4to.

Assuredly the naturalist whose first glance was so penetrating, would have cleared up the chaos in which these invertebrate animals were enveloped, had he continued to pursue the investigation; but unfortunately, he published his ideas before they were sufficiently matured.

He did not separate the sepiæ from the slugs so much as they should be separated; he imagined the medusæ to have an affinity to these two genera which they do not possess; he admitted also an affinity, which does not exist, between the bivalves and the echinodermata; and, lastly, he associated with these latter, on the one hand, the actiniæ, which are zoophytes; and, on the other, the sea-acorns or balani, which are much more closely allied to the bivalves.

These errors, which a little more examination would have enabled him to have avoided, contributed, perhaps, to reserve for other times a necessary revolution in the track to which he was advancing,—so much are the conquests of mind, like other conquests, subject to be arrested by the smallest accident. The most astonishing circumstance is, that he himself should have overlooked these beautiful perceptions. Having returned to Berlin in 1767, he reprinted, with many additions, his *Miscellanea*, under the title of *Spicilegia Zoologica*, and omitted unquestionably the most valuable memoir of the first collection; nor did he ever again turn his mind to the subject.

These two works spread wide the reputation of Pallas, and various governments made proposals to him. Perhaps he would have preferred his own, had he received the least encouragement from it; but, as too often happens, it was in his own country that his value was least appreciated. When thus under the necessity of quitting his native land, he did not hesitate what other to select. The country which presented a newer field to his researches was preferred, and he accepted a place which was offered him by Catherine II. in the Academy of Petersburg.

The Russian Empire, in the ninth century, the period at which history begins to speak of it, already almost extended from the Baltic to the Euxine Sea. Its existence was first announced to Europe by its bold enterprises against the Turkish Empire. Being soon converted to christianity, its sovereigns allied themselves with the Kings of France, and entered into po-

litical relations with the other potentates. An imprudent division gave rise to discord in their states, their best provinces were conquered by the Poles, and they themselves became tributary to the Tartars for three centuries. They at length cast off this yoke, and became conquerors in their turn; but, during their subjection, literature and civilization had reappeared in Europe, and Russia, at her restoration to freedom, found herself at an immense distance behind the other christian states. The first English who landed there, in the sixteenth century, considered it almost as a new discovery. Peter the Great made astonishing efforts to introduce into it the customs and knowledge of Europe. After passing through all the ranks, to habituate his great nobles to military subordination, after working as a carpenter, in order to form a marine, he wished to be admitted as a member of the Academy of Science of Paris, for the purpose of inspiring his people with a taste for instruction; but, in the accomplishment of these objects, his success was not equal: The army was promptly subjected to the German mode of discipline; the court quickly assumed the French manners; while, to have an academy, it was necessary to bring its members entirely from other countries, and to keep it up for a long time by recruits from them.

Germany, where the numerous cities and universities produced in some measure a superabundance of instruction, constantly supplied these deficiencies, and many of her most illustrious literati found in Russia a fortune, and means of prosecuting their favourite pursuits, which, perhaps, they could not have enjoyed in their own country. It was thus that Bernoulli, Bayer, Euler, Gmelin, Müller, Amman, Lowitz, Duvernoy, gave to Europe that beautiful series of labours, under the title of the Memoirs of the Academy of Petersburg; it was thus that they laid open to us, in all its relations, the immense territory of Russia, and, it may be said, made it known to the Russian Government itself.

In fact, no sooner had the Grand Dukes of Russia obtained possession of the throne and title of the Czars of Tartary, their ancient sovereigns, than some enterprising adventurers pushed their way toward the East. The most prudent settled among the mountains rich in ores of every description, which form the

true boundary of Europe and Asia; while others attacked the only remaining princedom of any consequence that existed in these barbarous regions, and delivered up his states to their Czar. As soon as the Russians had gained a footing on the Irtisch and Oby, their inquiries after furs and mines drew them farther on; by degrees they imposed some tributes upon the wandering tribes of those vast solitudes;—and thus, in less than a century, established that strange empire which, in its extreme limits, touches America, Japan and China, and in which a few thousands of soldiers are sufficient to guard 1500 leagues of country.

But to enjoy in reality the possession of such a territory, it was necessary to become properly acquainted with its nature and resources, and, after having conquered it, it became expedient to commence its real discovery.

To the genius of Peter the Great this task also was reserved. He was the first European monarch to whom the glory belongs of having conceived those purely scientific expeditions, on a great scale, in which men possessed of various kinds of knowledge, and aiding each other in their labours, examine a country in all its relations, expeditions of which antiquity presents some examples, but which France and England carried to their greatest perfection at the end of the last century, by limiting their objects solely to that of enlightening Europe, and presenting to savage man some of the advantages of civilization.

Hence, Messerchmidt of Dantzic traversed the whole of Siberia, between the years 1720 and 1725; and brought back an immense collection of observations; but the death of the Czar proved fatal to his prospects, his labours were neglected, and he died in misery. In 1733, the Empress Anne Iwanowna, niece of Peter the Great, who displayed on the throne a character very different from that which those who caused her to mount it imagined her to possess, resumed the projects of her uncle.

A more numerous commission, which lasted ten years, procured for natural history the excellent memoirs of Steller, and those of John George Gmelin, the head of a more numerous family, and not less celebrated in that science than the Bernoullis were in mathematics.

The troubles which followed the death of Anne, and the ne-

glect and discouragement which foreigners met with in the reign of Elizabeth, occasioned these first attempts to be lost sight of; but Catherine II., who had in view to make the path by which she came to the throne forgotten, amid the glory of every kind with which she invested herself, could not overlook so efficacious a means. Besides, her attention was roused to this object by a particular circumstance.

At the time of the first transit of Venus, in 1763, France had sent the Abbé Chappe d'Auteroche to Tobolsk, in order to make astronomical observations. On his return he published a narrative, the sarcastic tone of which so irritated the Empress, that it is said she took the trouble of refuting it herself.

She was therefore unwilling that foreigners should undertake the observation of the second transit, which was to take place in 1769; and, in selecting for this object astronomers from her own academy, she judged it necessary to send along with them naturalists capable of examining the country.

Pallas had the good fortune to see himself appointed to take a part in this undertaking. Good fortune I call it, because he looked upon this appointment as such. A distant journey cannot fail to be attractive to a young man, and more especially to a young naturalist; and this desire of searching for new productions has probably deprived us of many discoveries of the mind. Pallas himself furnishes a proof of this; for although endowed with an activity that knew no limits, and less exposed than any one to allow himself to be distracted from his meditations by fatigue, it cannot by any means be doubted that he would have rendered more benefit to science by his genius than by his journeys.

He displayed in a striking manner the union of these two qualities during the space of about a year that he remained at Petersburg. In the midst of all the preparations for so great a journey, he digested several new writings *, and gave to the Academy his famous memoir on the bones of large quadrupeds that are found in such abundance in Siberia, in which he shews that there occur in that country elephants, rhinoceroses, buffaloes, and many other southern genera, and that their quantity is almost incalcu-

* Printed at Berlin during his journey from 1769 to 1774.

lable * ; facts which first excited the attention of naturalists to these astonishing objects, and which laid the foundation of that beautiful superstructure which has since been reared.

The expedition, however, after receiving its instructions from the Count Wladimir Orlof, president of the academy, set out in June 1768. It consisted of seven astronomers and geometricians, five naturalists, and several students, who were to proceed in different directions over the immense territory which they were destined to traverse.

Pallas, in particular, after traversing the plains of European Russia, and wintering, in 1769, at Simbirsk, on the Wolga, in the midst of the Tartar tribes, the ancient conquerors of the Russians, and now in a great measure agriculturists, stopped at Oremburg on the Jaik, the rendezvous of those still nomadic hordes, which wander in the salt deserts, to the north of the Caspian Sea, and of the caravans which carry on the trade between India and Europe.

Descending from the Jaik, he remained for some time at Gouriel on the Caspian, and observed with care the nature of that great lake, which, according to him, was formerly of much greater extent, and whose ancient banks are still to be recognised at a great distance toward the north and north-west.

The year 1770 was employed in visiting the two sides of the Uralian Mountains, and the numerous iron mines which are wrought in them. It is here that Russian adventurers have acquired, in a few generations, fortunes which have put them on a level with the greatest nobles of Europe.

After visiting Tobolsk, the capital of Siberia, Pallas wintered at Tcheliabinsk, in the centre of the more important of these mines.

From this place he proceeded in the spring of 1772, to another district, rich in mines, viz. the government of Koliwan, which is situated on the northern slope of the Altain Mountains, a great chain which extends from east to west, and which, by repelling the winds from the south, renders the climate of Siberia much colder than might be expected from its latitude. In these mines many traces of old workings are found, which

* Nov. Comm. Petrop. xiii.

Bailly attributes to the ancient northern tribes, in his opinion the first inventors of the arts and sciences. Pallas proves, on the contrary, that these works were carried on by the ancestors of the Hungarians of the present day, who, it is known, derive their origin from a nation that arrived in these countries in the seventh or eighth century. This journey terminated at Krasnojarsk on the Jenissei.

The year after, our traveller, always proceeding eastward, crossed the great Baikal Lake, and passed through the mountainous country, known by the name of Daouria, which extends to the Chinese frontiers. It was only here that he began to observe the productions of nature, to assume an appearance entirely different from those of Europe. The plants exhibit singular forms; animals of genera unknown to us, clamber among the rocks, or sometimes straggle thither from the great deserts of central Asia.

Pallas, after viewing a multitude of half savage tribes, at length came once more upon a civilized nation, the civilization of which, however, in none of its forms resembles that of Europe. He could not help considering the Chinese as a race which has been separated from us, at least since the last catastrophe of the globe, and which has followed in its development an entirely isolated course.

After retracing nearly his former steps, and passing the winter a second time at Krasnojarsk, our traveller returned in 1773, to the Jaik and the Caspian Sea, visited Astracan, and examined the Indians, the Bucharians, and the other inhabitants of the centre and south of Asia, who were mingled with the heterogeneous population of that city. He approached the Caucasian chain, the native country of the white race of men, as the mountains of Daouria appear to be of the yellow race, passed another winter at the foot of the branch of mountains which separates the Wolga from the Tanais, and at length returned to Petersburg, on the 30th July 1774.

While thus pursuing the principal route, he sent off in various directions pupils who were under his direction.

Pallas employed the leisure of his winter quarters in drawing up his journal; and, according to the plan prescribed by the

Count Orloff, he sent it every year to Petersburg, where its volumes were successively published *.

It may be conceived that, labouring in this hurried manner, and destitute, in these solitudes, of books, and of every means of comparison, he would necessarily be exposed to fall into some mistakes, would bring forward things already known, as if they were new, and would repeat the same things several times. We must allow, too, that he might have given more animation to his narrative, and presented the interesting objects of which he treats in a more prominent manner. His long and dry enumeration of mines and forges, his repeated list of common plants which he gathered, or of ordinary birds which he saw passing, do not form agreeable reading. He does not transport his reader along with him; he does not place, as it were, before his eyes, by the power of his style, as more happy travellers have done, the grand scenes of nature, or the singular manners which he witnessed; but it will undoubtedly be allowed in excuse, that the circumstances under which he wrote, were not of the most inspiring description.

Winters of six months' duration, passed in huts, far from any thing connected with literature, with black bread and brandy for his only restoratives; a degree of cold so intense as to cause mercury to freeze; summers insupportable from their heat during the few weeks which they lasted; the greatest part of the time of his journey employed in scaling rocks, fording marshes, in making his way through woods by felling trees; those myriads of insects which fill the atmosphere of northern countries, covering him every moment with blood; tribes of men impressed with all the miseries of the country, disgustingly slovenly, often frightfully ugly, and always stupid in the highest degree; the Europeans themselves brutalised by the climate and by indolence—all this might well have cooled the most lively imagination.

After a long voyage, the smallest spot of earth, the slightest appearance of verdure, seem a paradise to the navigator, and when it is on the Friendly Islands, or at Otaheite, that he lands,

* The first volume appeared in 1772, in quarto; the second in 1773, and the third in 1776, in German, with a great number of plates and maps. There is a French translation by M. Gauthier de la Peyronie, in four volumes, quarto, Paris 1777; and a second edition with notes by MM. Lamarck and Langles. Paris, second year of the Republic, eight volumes octavo, with an Atlas.

he becomes a poet in spite of himself. At Kamtschatka, is it not enough that one have barely the power to write?

Pallas, young and vigorous as he was, returned enfeebled by the sufferings consequent on so painful a journey. At the age of thirty-three, his hair was grey; repeated dysenteries had diminished his strength; obstinate ophthalmia had threatened him with loss of sight. His companions were still more exhausted and reduced; scarcely any of them lived long enough to publish his narrative himself, and it was upon Pallas that the task of rendering this tribute to their memory also devolved.

The great objects which he had seen, had impressed themselves too forcibly upon his mind, to allow him to remain contented with the journal which he had hurriedly traced of them. He had profoundly observed the earth, the plants, the animals and the men; his observations, cherished and combined by reflection, became to him the subjects of so many works, in which he clearly displayed his power. He gave the history of some of the most celebrated animals of Siberia, the musk, the glutton, the sable, the white bear *; and this history is so full and so well related, that it may be said there is not a quadruped, not even the most common, so well known to us as these.

The glires alone furnished him with matter for an entire volume, so numerous were the species which he had discovered. Their history and anatomy were treated with all the richness of which Buffon and Daubenton alone had hitherto given an example; and although, from modesty, he did not form new genera of them, his descriptions were so well executed, that any intelligent systematist could readily extract the generic characters.

The class of quadrupeds also owes to him the accurate knowledge of a species of solipede, intermediate between the ass and the horse, a sort of natural mule which is propagated in the deserts of Tartary †; that of a new species of wild cat from which he thinks our Angora cats are derived ‡; it owes also to him more perfect ideas than had previously been formed regarding the wild ass of these deserts ||, regarding the small buffalo, whose

* These last four numbers appeared from 1773 to 1780. M. Rudolphi mentions that he intended to print six more of them.

† Equus hemionus, Nov. Com. Petrop. xix. p. 394. pl. 7.

‡ Felis Manul, Ibid. 1781, Part i.

|| In the new Nordische Beyträge. v. ii. p. 82. pl. 1, and in the Act. Petrop. I.

tail, furnished with long hairs like that of the horse, supplied those marks of military dignity which the Turks have borrowed from the Tartars, their ancestors *, and regarding the small yellowish foxes of the deserts of the north of India, which some have imagined to be the pretended auriferous ants of Herodotus†.

It is much to be regretted that Buffon took no notice of these valuable accounts of quadrupeds; their unaltered translation would have formed a beautiful ornament to a work which Pallas took as his model, and to which he certainly is not inferior in the parts which he has treated.

It is impossible for us to enter into a detail of all the birds, reptiles, fishes, mollusca, worms and zoophytes, of which he was the first who published descriptions. The mere enumeration of the numerous memoirs which he printed among those of the academies of which he was a member, would much exceed the limits that are prescribed to me. He was not even frightened at the immense project of a general history of the animals and plants of the Russian Empire, and had even put it in execution to a great extent, although such an undertaking must have presented more difficulties to him than any other.

In fact, it was, so to speak, when on his journey that he became a botanist; for, until then, the history of animals was the study that he preferred. The descriptions of plants, also, which accompany his journal, have incurred some censures; but he had scarcely arrived, when he engaged with ardour in this pursuit. The Empress, whose taste the Flora Rossica flattered by its magnificence, ordered to be transmitted to the author the herbaria collected before his time by the travellers that had been sent out by the government, and took upon herself the expence of the engraving and printing. He himself had made considerable collections of plants, and the work promised to extend, in a remarkable manner, our knowledge of the vegetable kingdom; but no more than two volumes of this work were published ‡, which principally contain the trees and shrubs. There are only a few plates of the third, because in Russia, as elsewhere, the

* Bos grunniens. Act. Petrop. I. Part. ii. p. 332.

† Canis Corsac, Neue Nordische Beytrage, i. p. 29.

‡ Flora Rossica, seu Stirpium Imperii Rossici, per Europam et Asiam indigenarum, Descriptiones et Icones. Folio. Petersburg, 1784 and 1788.

smallest change in the administration stops the most important publications, when they have no immediate connection with the interests of the government at the time. Pallas afterwards gave to the world a part of his botanical discoveries in works that were less magnificent, but which he was able to publish without foreign aid.

Of these his history of the Astragali was the first *. He then gave a history of the Halophytes, or those maritime plants of the family of the Salicorniæ, so abundant in the steppes, or plains of sand impregnated with salt, which cover the southern parts of Russia †. The Absinthiæ and Artemisiæ which are not less abundant on these steppes, and which had already been remarked there by the ancients, were to form a sequel to the Halophytes; but the misfortunes occasioned by the war in Germany stopped it at the 59th plate.

The interruption of his great Flora of Russia did not prevent him from undertaking a work, equally general, on the animals of that empire, a country which produces almost all those of Europe, the greater part of those of Asia, and which, moreover, possesses a great number peculiar to itself. A volume of this work was printed in Petersburg, but it has not been published ‡. Pallas laboured at it until his last moments, and has left the whole manuscript relating to the vertebrate animals. M. Rudolphi, who knew him, asserts, and it will easily be believed, that it contains several new species, and many interesting observations.

He had commenced a distinct work on the Insects of Russia, of which only two numbers have appeared §.

It is seldom that men so laborious, occupied with conducting at once so many undertakings, have their judgment sufficiently exercised to conceive those fundamental ideas which are calculated to produce revolutions in science; but Pallas forms an exception to this rule. We have seen how near he was to effecting a

* Species Astragalorum Descriptæ et Iconibus coloratis instructæ. Fol. Leips. 1800.

† Illustrationes Plantarum imperfecte vel nondum cognitarum. Fol. Leips. 1803.

‡ Fauna Asiatica-Rossica, Petrop. 1811 and 1812.

§ Icones Insectorum præsertim Russiæ Sibiriæque peculiarium; Erlang, 1781 and 1782. 4to.

change in the aspect of zoology; and in that of the theory of the earth he effected a real change. An attentive consideration of the two great mountain chains of Siberia enabled him to discover the great law which has since been found to hold good universally, of the succession of the three primitive orders of mountains, the granitic in the middle, schistose on their sides, and limestone mountains outermost. It may be said, that this great fact, distinctly expressed in 1777, in a memoir * read to the Academy in the presence of Gustavus III. of Sweden, was the origin of the present system of geology: Saussure, Deluc and Werner, set out from it to arrive at the true knowledge of the structure of the earth, so different from the fanciful ideas of preceding writers.

Pallas, besides, rendered a very great service to geology by his second Memoir on the Fossil Bones of Siberia †, in which he brings together all that he had observed concerning them during his journey, and especially relates the fact, then almost incredible, of a rhinoceros having been found entire in the frozen earth, with its skin and flesh. The elephant discovered on the sea-shore in a mass of ice, and in such good preservation that the dogs eat its flesh, has confirmed this important observation, and given the final blow to Buffon's theory regarding the gradual cooling of the polar regions.

Pallas was not so happy in his hypothesis of an eruption of waters coming from the south-east, which might have transported and buried in the north the animals of India. It is now clearly demonstrated, that the fossil animals are very different from those of India.

The great mass of iron which he observed near the Jenissei, was also an entirely new phenomenon in mineralogy ‡. This mass lay isolated on the surface of the ground, on the summit of a mountain, far from any vestige of a volcano or of mining operations. It weighed 1600 pounds. The metal, which was perfectly malleable when cold, was vesicular, and contained vitreous matters §. The Tartars said it fell from heaven, and re-

* Observations on the Formation of Mountains; Act. Petrop. 1778. Pars I. &c.; and separately in 12mo. Petersburg, without date, reprinted at Paris in 1779 and 1782.

† Nov. Comm. Petr. xvii.

‡ Act. Petrop. Pars I

§ This vitreous matter is olivine.—Ed

garded it as sacred. It also contributed to make known M. Chladni's conjectures respecting the truth of the falling of stones from the atmosphere; a conjecture now as plainly confirmed by the observations of a few years, as the most anciently announced truths could be.

Pallas's memoir on the degeneration of animals * also presents many ideas, which, if not demonstrated, are at least original. The unvarying character which horses, oxen, camels, and other domestic animals, which have few allied species, or whose hybrids are sterile, present, compared with the infinite variety of races of dogs, goats and sheep, whose genera consist of numerous species which produce with one another hybrids capable of propagating, leads him to suppose that the three last species of animals are in a manner factitious, being produced by the diversified alliances of natural species. He thinks, for example, that the shepherd's dog, and the wolf-dog, owe their origin to the jackal, the animal which appears to him, as well as to Guldenstedt, the most closely allied to the dog, such as we now see him; the mastiff seems to him, on the contrary, to come from a mixture with the hyena; the small dogs with sharp muzzles, from the fox.

But the writings we have hitherto noticed are only important to the naturalist: his history of the Mongol nations ought to prove interesting to every man of education †, for it is perhaps the most classical piece of composition that exists in any language on the subject of the origin of nations.

The name of Mongols might be extended to all those tribes of the northern and eastern parts of Asia, whose oblique eyes, yellow tint, black and lank hair, spare beard, and prominent cheeks, render them so hideous in our eyes, and of which a tribe devastated Europe, under Attila, in the fifth century. It belongs, however, in a more peculiar sense, to another tribe, which, under Gengis Khan, in the eleventh century, laid the bases of the most formidable dominion which has yet existed upon the earth. China, India, Persia, and all Tartary, were successively subjected by them; they rendered Russia tribu-

* Acta Petrop. 1780, pars ii. p. 62.

† Collection of Historical Documents regarding the Mongol Tribes; in German, 2 vols. 4to, with many plates. Petersb. 1776 and 1801.

tary, and made irruptions into Poland and Hungary. But after a few centuries, fortune became adverse to them. Driven out of China and Persia, destroyed in India, subjected to the Russians in the western parts of their ancient conquests, and to the Chinese in their original country, they have only preserved independent establishments in some districts to the west of the Caspian Sea. Having returned to the pastoral life, most of them wander, like their ancestors, in the vast deserts of central Asia, waiting until the discord or decay of the neighbouring empires permits some enterprising adventurer to collect them for new conquests. This is what Russia and China seek to prevent, by dividing them, reducing their number, and sometimes transplanting them, when they mutiny, to enormous distances. And yet, in this state of subjection, these unfortunate beings preserve the pride of rank and nobility; they have long genealogies; their chiefs cabal against one another, and intrigue at the court of their sovereigns for augmentations of authority. The Grand Lama, who governs the consciences of all these tribes by a hierarchy almost as absolute as that of the Romish church, gives a sacred character to this authority by his patents, which thus become in his hands a means of intrigue and of disturbances. These continual agitations cannot be better represented than by the recital of an event which Pallas relates in detail, and which may even afford us an idea of those famous migrations of tribes which form so remarkable an epoch in the history of Europe.

An entire tribe, which, after the conquest of the last Emperor of China, Kien-Long, had taken refuge in the Russian territory, and which had settled, in 1758, in the deserts of the country of Astracan, having somehow become discontented, and being moreover excited by the intrigues of their principal Lama, resolved, twelve years after, to return to the countries subjected by the Chinese. The preparations necessary for their journey were continued during several months, without any one divulging the secret. At length, on a fixed day, in the beginning of 1771, the whole nation, men, women, and children, to the number of more than 60,000 families, emigrated in three divisions, carrying away their tents, their flocks, and their baggage, and taking

with them whatever they met with on their route, whether men or treasure. In this manner, they travelled upwards of 500 leagues, without being arrested either by the troops that were sent after them, or by the rivers, the attacks of the tribes which they met with, or the mortality of their people and animals. Nothing like this had occurred since the flight of the Children of Israel from Egypt.

Pallas not only treats of the origin and physical characters of these tribes, their manners and government, but also devotes a great part of his work to the exposition of their religion,—a religion of a singular nature, which had been banished from Indostan by the Bramins, in the first century of our era, and which, at the present day, being the predominant religion in China, Japan, the half of Tartary, Ceylon, and the whole of the peninsula beyond the Ganges, almost equals, in point of extent of territory, Christianity and Mahomedanism. The metaphysical doctrines on which it is founded, its dogmas, its moral maxims, its canonic right, its ceremonies, and even the vesture of its clergy, have so great a resemblance to Christianity, as to have astonished, and sometimes deceived, our missionaries; but, at the best, it would merely be a Christianity altered by the most monstrous adulteration. The supreme chief is not only the vicegerent of God, he is God himself, who is successively incarnated in all the individuals raised to this dignity. Some of the inferior chiefs also partake of divinity. The Chinese monarch acknowledges this claim to it; but, to prevent their abusing it, he has taken care to make himself master of their sacred cities, and their spiritual authority is only exercised under his influence. In this religion, as in many others, a schism has taken place, and, for about two centuries back, there have been two independent Grand Lamas. As in some other religions also, these two chiefs long denounced each other; but the singular circumstance, and one which they alone have exhibited, is, that they have become reconciled to each other; that they mutually recognise each other as gods, and that their partisans live peaceably together throughout all Tartary.

The schism originated in a reigning Lama pretending to admit women to the honours of the priesthood. The rigid followers of the ancient customs would not pardon him for such

a scheme, and the consequence was, that he lost two-thirds of his empire.

Pallas does not leave us ignorant of any of the mysteries or rites of this religion. In general, he displays as much capacity for detailing the customs and opinions of nations, as he proved himself qualified, in his first works, to describe the productions of nature. It is difficult to comprehend why this work has not been translated, while so many insignificant journeys are daily issuing from the press.

An essential part of the history of nations, that which leads us farther back than all written documents, is the knowledge of their languages. It is by this, and not by any traditions, that we may be enabled most successfully to judge of their descent, and to trace their genealogy; and there is no government in existence better calculated to favour this important study than the Russian, the subjects of which speak more than sixty different languages. The Empress Catherine II. formed the ingenious idea of getting comparative vocabularies drawn up of all the tribes subjected to her sceptre *; she herself laboured at it for some time, and directed Pallas, who of all her literati had seen most tribes, and learned most languages, to collect the Asiatic vocabularies, restricting him, however, to the list of words which she had drawn up. It will not afford matter of surprise, that a woman and a sovereign should not have selected these words so usefully, and with such profound views, as a professed etymologist would have done; and it is difficult to imagine how those whom she appointed her fellow labourers in this work, had not ventured to represent to her the defects of her plan. Besides, it will be perceived that a mere vocabulary could not afford an idea of the mechanism and spirit of languages; but still it was a valuable work, and one that has been highly useful to other literati in their researches.

The Empress bestowed on Pallas many other marks of her confidence. He was an active member of the Commission appointed in 1777, with the view of making a new Topography of the Empire; he was named Historiographer of the Admiralty, a situation which obliged him to give his opinion on scientific ques-

* Linguarum totius orbis vocabularia comparativa, Augustissimæ cura collecta. 2 vols. 4to. Petersb. 1786 and 1789.

tions relative to the navy; the Grand Duke Alexander, afterwards Emperor, and his brother Constantine, received instructions from him in natural history and physics.

Employed in so honourable a manner by the Government, decorated with titles proportionate to his employments, applauded by the learned world, Pallas enjoyed at Petersburg all the consideration that could be allied with his quality of foreigner and his state as a mere literary character; but it appears that the habit of travelling, like that of the savage life, renders an abode in cities difficult to be endured.

Equally fatigued with his sedentary life, and with the crowd of people of the world and of foreigners, for whom the house of so celebrated a man was a natural rendezvous, he seized with avidity the opportunity which the invasion of the Crimea afforded him of visiting new countries, and employed the years 1793 and 1794 in traversing, at his own expence, the southern provinces of the Russian empire *.

He revisited Astracan, and traversed the frontiers of Circassia, a mountainous country, which produces the most beautiful of all the races of the human species, and the singular manners of whose inhabitants may have given rise to the fable of the Amazons; the married men can only see their wives in secret, and by introducing themselves under night through their windows. This country is besides singularly remarkable for the multitude of tribes, differing from each other in their forms and languages, that inhabit its defiles, forming the remains of the tribes which passed through it at the time of the great migration of the nations. The Huns, the Alans, the Uzes, the Avares, the Bulgarians, the Coumanes, and Petchenegres, and those other barbarians, whose names were almost as frightful as their cruelty, have left colonies amidst the rocks of the Caucasus, and there Man may be gathered as it were by specimens.

But Pallas did not chuse to risk himself among tribes, which, although interesting in a high degree, are yet very dangerous.

* We have the account of this Journey also in German and French, 2 vols. 4to. Leips. 1799 and 1801, with many beautiful coloured plates, and there has lately appeared a new French translation, with notes, by MM. de la Boulaye and Tounelier. Paris 1811.

He afterwards proceeded to the Crimea, the ancient Tauris, a singular peninsula, flat, and arid on the side by which it is connected with the continent, and raised on the opposite side into mountains which inclose beautiful and fertile valleys. Formerly civilized by Grecian colonies, occupied during the middle ages by the Genoese, afterwards inhabited by the Tartars, who at length acquired tolerably peaceable manners, it has of late fallen into the hands of the Russians. It is well known with what preparation Potemkin led the Empress into this new conquest, and by what prodigies of expence and despotism this favourite gave for a few days to deserts the appearance of fertile and flourishing countries. It may be said that Pallas participated in the illusion of his sovereign, or perhaps the contrast between the pleasant valleys of the coast, opening to the south, enjoying a view of the sea, and planted with vines and roses, and the melancholy plains of the north of Russia, struck him too forcibly. He drew an enchanting picture of the Tauris*, and, as a proof that he was sincere in his praises, hastened to obtain for himself a retreat in it.

Repose, which he had so long shunned, had now become necessary to him. In his last journey, wishing to examine the banks of a river, the surface of which was frozen, the ice broke under him, and he sunk in the water to the middle. Remote from all assistance, and during a very intense cold, he was obliged to travel for several leagues, without a change of dress. This accident occasioned pains, which he hoped would be alleviated in a milder climate than that of Petersburg; but his change of residence, far from producing this effect, only added to his physical sufferings evils more insupportable, chagrins and cares of all kinds.

The empress, informed of the desire which Pallas shewed of living in the Tauris, very handsomely presented him with two villages, situated in the richest district of the peninsula, and a large house in the city of Achmetchet, named by the Russians Sympheropol, which was then the chief place of the country, and with a considerable sum of money for his establishment.

* Tableau Physique et Topographique de la Tauride (Nov. Act. Petrop. tom. x.), re-printed at Paris in the year vii. (1800.)

Pallas betook himself thither in the end of 1795; but this climate, which had appeared to him so fine during a short residence, proved, after more experience of it, inconstant and moist. The beautiful valleys were rendered pestilential in autumn by marshes; the winter was very severe; the inconveniences of both the north and of the south were felt in it. Besides, property bestowed somewhat loosely, because it was thought entirely dependent upon the old demesne of the Khans of the Crimea, became in part liable to be disputed, and involved the new possessor in endless processes. Lastly, and worst of all, Pallas had not sufficiently considered what a void he would experience, when, being removed from all the learned world, he would find it impossible to communicate his ideas. He was quickly undeceived, and expressed his chagrin with bitterness in the preface to the second volume of his second journey.

He passed, however, nearly fifteen years in the Crimea, occupied with the continuation of his great works, and with the exercise toward strangers of the ancient hospitality of the country; labouring especially at a project of the highest importance to Russia, that of improving the culture of the vine, of which he had made great plantations in the valley of Soudac, the ancient Saldaca of the Genoese. He judged the country so much the better adapted for this purpose, that he thought he had found the vine in a wild state in it, although what he saw was perhaps nothing else than the remains of the ancient vineyards of the Greeks. But no occupation could reconcile him to so melancholy a life; and the marks of esteem which he received from Europe, only served to increase his regret at having left it, and made him the more sensible of what he had lost by doing so. At length, resolved to tear himself from his situation, he sold his lands at a very low price, bade adieu for ever to Russia, and returned, after an absence of forty years, to close his life in his native city.

To a man who had lived fifteen years in Little Tartary, this was like coming back from the other world. Some old friends whom he found seemed to him to recal his youth; he resumed his former warmth and eloquence when he was informed of the new advances of science, the rumours of which had but imper-

fectly made its way to his retirement. His depressed spirits seemed entirely to revive with these sudden enjoyments.

The young naturalists, formed by his works, brought up in the admiration of his genius, but to whom he had been but an invisible oracle, listened to him as to a superior being come to judge them; for his long absence had multiplied the time, and put as it were several generations between them and him. They assert, that, in the frank and prompt approbation which he gave to the new discoveries, there was in fact to be recognised in this good old man, a mind superior to the prejudices natural to his age. He treated his new disciples as a father, and not with the dogmatism and superciliousness of an old master. It is a beautiful trait in his character, that he was little disposed to criticise, and willingly gave to his contemporaries the praises which they deserved,—an effort fully as meritorious as that of giving them to his pupils. He is also perhaps the least criticised by others of any distinguished writer of the eighteenth century. He has sometimes been reproached with somewhat of keenness and severity, for bringing together, for engrossing, as it were, by every possible means, the observations or the objects of study collected by others,—a quality calculated to displease those whose particular labours might be lost in the mass of glory, which legitimately belongs to the man who has conceived a great plan, but without which a multitude of facts, useful only from their association, would have been lost to science. Nor did he ever make use of the observations of others, without explicitly rendering justice to their authors.

Having thus returned to the country which had given him birth, and to friends who appreciated his merits; having again drawn near to an elder brother, toward whom so long a separation had only caused his natural attachment to become stronger; attended by his only daughter, who cherished him with the greatest tenderness, Pallas still had the prospect of some happy years. He read with interest the new works on Natural History; he proposed to visit the cities of France and Italy that were richest in instructive collections, to form acquaintance with the distinguished men which they possessed, and thus to collect new materials for a concluding work. But the germs of diseases which he had contracted on his journeys, and during his

residence in the Crimea, developed themselves sooner than had been anticipated. His old dysenteries returned to such a degree, as to make him easily foresee that he could have no longer any resource, and, without tormenting himself with useless remedies, he employed his last days in making the necessary arrangements for ensuring the continuation of the works which he left incomplete, and for disposing usefully of what there remained with him of objects and observations to be published.

He died on the 8th September 1811, aged seventy years, within a few days.

He was twice married, and left a daughter, whom he had by his first wife, and who is now widow of the Baron Wimpfen, Lieutenant-General in the service of Russia, who died at Luneville, in consequence of wounds received at the battle of Austerlitz.

From the distance at which Pallas always lived from us, it would be difficult to collect enough, respecting his character, to describe it with certainty. It may be seen, by what he has produced, to what degree he united sagacity with the ardour for labour. The peace in which he lived with his rivals indicates mildness of disposition, for it is difficult to attribute it to mere prudence; and although nothing so much disposes one to exercise benevolence as his experiencing it himself, yet there is more in his never having attacked any person, than merely that no one ever attacked him. Those who knew him, moreover, boast of the equanimity of his temper and his cheerfulness; he loved pleasure, it is said, but only as relaxation, and without thinking it worthy of disturbing his repose. In a word, he appears always to have lived as a man of science should, occupied solely in seeking after truth, and leaving the rest to the chances of this world. The more experience one has, the more will he be sensible that such a mode of life is, on this earth, the surest means of neither endangering his well-being nor his conscience.

Observations on the Large Brown Hornet of New South Wales, with reference to Instinct. By the Rev. JOHN M'GARVIE, A.M. In a Letter to JAMES DUNLOP, Esq. Paramatta *.

DURING occasional hours of relaxation from more important engagements, I have amused myself of late in studying the habits and history of the large brown and black hornets of this country, which I know you have also done with much success. But as my views on the subject do not entirely coincide with yours, I cannot permit this, perhaps the last opportunity for many months, to escape without making a few remarks upon it, especially as the excellent microscope I received from you (a present of inestimable value in this country), will enable me to prosecute the subject with more precision than I have yet been able to accomplish.

There are few subjects that have occasioned more discussion to the naturalist and the moralist than instinct. The one, desirous of resting his knowledge on a few mechanical principles, is unwilling to admit instinct as a direct operating agent in animals, and particularly in insects, if any cause can be discovered that will account, even imperfectly, for their operations. The moralist, on the other hand, assigns to instinct every thing that indicates an ultimate design, though it cannot be a question with any man, that the same veneration for the Author of Nature would be excited, were every act of instinct reduced to the commonest laws of matter and motion. For He who implanted instinct, on the common view of the matter, must have implanted also the power of acting in conformity to known laws; and these actions, of course, become infallible proofs, that the laws which these individuals follow in their operation, existed before the individuals themselves; giving thus a proof, if any were wanting, that both were created by the same beneficent hand. Instinct, therefore, we conceive, should always be considered as assisted or modelled by organic structure.

Of all the works of instinct, none have excited more surprise than those exhibited by Bees, Hornets, and other creatures of the same kind, which form their hexagonal cells with such

* Read before the Wernerian Natural History Society 12th January 1828.

regularity and skill, that the most expert artizan might in vain attempt to imitate or surpass them. Why is it they have chosen this best of all forms "'*stipare roscida mella*,'' by which every atom of their labour becomes of use? Why do they never deviate from this rule? Why have they never advanced in improvement since the first of the race completed his primitive cell? This, of itself, in place of leading us to assign the effect to instinct, should lead us to ascribe it to the structure of the race, impelled by some principle beyond the reach of investigation.

Instinct implies a power of action for producing some effect, by mechanical means, without the agency of intelligence. To this view of instinct we are not disposed to object, if men do not stop at proximate causes; for, whilst bodily conformation and structure may serve to attain certain ends, the principle from which these flow may still be denominated Instinct.

The hornets of which we speak, are of several kinds. There is a small black species which forms a quadrangular cell, about a quarter of an inch in the side, and from which a number of young ones, to the amount of ten or twelve, may sometimes be taken, of a dry, hard, brittle structure and glossy aspect, without wings, and the head very indistinctly formed. This nest is often attached to the leaf of a wattle, or gum-tree, in which case it is often hid by the leaves. It is firmly attached to the leaf by a thin gluten.

There is another very beautiful small nest, whose inmates we have not ascertained, but the form of which is more regular and surprising than that of the bee itself. It is six-sided, and the edges of the angles are formed into a rounded ridge.

The nest of the large black and brown hornet is extremely curious. It is fastened to the branch of a tree, sometimes a peach-tree, and sometimes to the twigs of a low shrub, close to the ground, and hid by high grass, being attached by a small button-shaped protuberance of dry, tough, gummy matter, which is impervious to rain or moisture, and which is, when taken off, in scales similar to the scales of a fish, but of a very different structure. They work downwards for about an inch, and then commence their cells, attaching the button of each cell to the stalk attached to the tree They have sagacity enough to know

that, as the weight below increases, the stalk and button must also be increased above, which they may be seen augmenting with great perseverance. They then increase the number of the cells, making them nearly equal in length, which is generally one inch and a half or two inches. The surface next the tree, that is, the bottom of the cells (for the open end is always downmost, and they build downwards), is covered carefully over with a gummy substance of a silky aspect, but dry and brittle. The bottoms of the cells externally are distinct and circular. The button and stalk are of a pyramidal figure, very broad near the base, and contracting as they approach the upper end next the tree.

At the bottom of each cell, and covered with a thin substance, like tissue-paper, is a dark brown substance, composed of particles of wood comminuted, and similar to saw-dust. It certainly is not the young animal, but it may be stored up as food for it in its earliest stages of existence. Each cell is cemented to those next it by a hard glutinous matter, which may be obtained in considerable quantities near the bottom of the cells, as they are all tapering below, and wide above. and the interstices are filled with this substance, by which they are joined to one another, and to the covering that spreads out from the stalk, by which it is fastened to the tree. The nests themselves are rounded below, and circular horizontally. The cells are not always exactly hexagonal; they are, however, placed in very distinct rows, but they are neither so elegantly formed as the cells of bees, nor do they contain any liquid, nor is any use made of their contents. The cells are about two-fifths of an inch diameter, of different lengths, and the breadth of the whole nest is seldom more than that of the crown of a hat.

The insects connected with one nest are not numerous, sometimes amounting to twelve or twenty, sometimes to a few more. When the cells are formed, they seem to take great pleasure in going over them in succession, pushing their heads into the cells, and adding small portions to them by means of their long tongues, palpi, and forceps. They hatch their young in these; and, when the young animal is in the cell, they close the mouth of it with the fine tissue-paper like substance, of which the sides of the cells are composed.

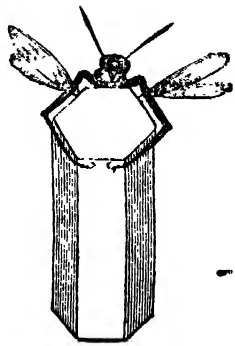
The stings of these insects are extremely painful, causing a fulness and deadness of the place affected, that is almost intolerable. Their sight is sharp and quick. They fly directly to the face. One man was stung, not long ago, in the centre of the eye. They attack the cattle in the field, which are terrified for them, except the pig, which is blessed with a happy insensibility to all their attacks, as he merely shakes his sides and his tail, and continues to eat peaches as before.

This insect has a beautiful appearance in the living state, having a number of yellowish-brown segments, on a black ground, around his body; his legs and wings being of the same colour; a fine yellowish colour presents itself on each shoulder, at the root of the wings, and there is a yellow stripe on the forehead. The rest of the body is a beautiful velvet-black, and the tips of the wings are tinged with a light purple colour. It has six legs, the two first of which it uses with great dexterity as hands. They may be seen frequently rubbing them, and thrusting their foot into their mouth, to besmear it with an unctuous substance, which may enable it to seize a firmer hold of its object.

It is from the structure of the fore-legs, which are admirably adapted for the purpose, that, in my opinion, the hexagonal cells derive their character of regularity. When the sun is hot, you may see the insect traversing round his cell, seizing the edge of it in his mouth, and adding a small piece to the sides. When he has done this, he sets his body close to a side, and clasping the cell firmly in his fore-arms, he continues rubbing it upwards and downwards for a considerable time; and as one cell is always a little higher than the one next it, he proceeds thus from side to side, and gives a six-sided form simply by rubbing and working upon the soft materials with his arms. A very little attention will shew, too, that he can give it no other form than this or the circle. For his arms are so constructed, that if he acts uniformly upon any of these sides or angles, as we have repeatedly seen him do, he must form a hexagonal figure, if the materials are pliant.

The arms are first composed of a joint near the body, extending a little outward, and moveable in every direction. To this is attached the arm, which is smooth, and somewhat power-

ful. Next this is the fore-arm, and next it are the feet, which have three hooks, a small one on each side, and a larger in front. Between each of these is a powerful joint, and they are confined to a large angle, as they cannot be extended into a straight line. When the animal, therefore, has made the sides of his cell in a circular shape by the gluten from his mouth, and a quantity of pipe-clay, which he frequently employs in the building of it, he applies his body to it, and, placing the fore-arms around it, at an angle most convenient for itself, he continues to rub up and down till the shape has been given to the cell. The first angle is formed by the body and the arm; the second by the arm and fore-arm, and the third on each side by the angles formed by the fore-arm, and the feet or claws*.



In proof of this, it may be remarked, that the bottom of the cells is round, and the hexagonal form does not commence till the cell has attained a sufficient height to admit of the application of the animal's body and legs to the outside of the cell, after which, to the top of the cell, the hexagonal form is remarkably distinct. Besides, to leave no doubt about the matter, we have measured the legs of a full grown hornet, and then applied them to the sides of the cells, and out of 160 cells in one nest, found only half a dozen near the outside that did not correspond exactly with the length of the arm or fore-arm, and these were probably injured or dried up.

In this respect, therefore, I think, that instinct may be pushed one step farther back from the demesnes of philosophy, since this very complicated and regular exhibition of animal sagacity may be accounted for from the organic structure and formation of the animal. The wonder still remains, why it should have been constituted with such powers. But this wonder is in common with that of every thing around us; and is continually excited in examining the wonders of the lower creation, especially in entomology, which, in this country, above all others, would require

* The figure is considerably larger than nature.

the united energies of a score of naturalists for many years. Its treasures are inexhaustible, and are almost entirely unknown.

When, upon this subject, allow me to allude to a circumstance connected with the beautiful *Atropus Belladonna.* This butterfly, in the state of a grub, as it is here called, forms a pyramidal and sometimes a circular nest of small twigs, which it may be seen occasionally dragging up a tree, by short and easy stages. This is the case with the same insect when very small; but in both stages, it may be seen moving about its head before it commences its journey, and stopping at regular intervals as if to reconnoitre. One unacquainted with its natural history, might suppose it was apprehensive of danger. But the fact is, that when it moves its head from side to side, it is spinning for itself a thread, which it fixes to the tree, and, when it is strong enough, it stretches out its fore claws, seizes hold of the thread, and raises itself upward, on the principle of the common rope-ladder. When you examine its path attentively, you see these steps placed at the most regular distances, as regular as if made by the hand of art, and intertwined in such a way, that if one should break, the next will keep the animal up This is certainly instinct in one sense, but is common mechanics in another. For the animal seizes hold of the thread by the second pair of feet, stretches his head upwards, and makes the distance between the two steps of the ladder precisely that of the distance between his mouth and his second pair of arms, which is exactly one-fifth of an inch in a common sized animal. We have watched him ascending a smooth surface by this means, when it would have been thought impossible to raise a large circular cylindrical nest with so much dispatch on such a surface. Such paths you have probably yourself seen long ago.

Ascribing effects to instinct, therefore, is a great source of error in natural history, and should not be resorted to, except in those cases in which no rational account can be given of the effect we contemplate; for if men were to stop short at second causes, every effect in nature might be denominated instinctive. The best possible means have been always adopted to produce the best possible ends. It is the business of philosophy to discover the latter, and trace them by that means to the grand intelligent source whence they originated. I am, &c.

Analysis of the Gil-i-toorsch, or Sour Clay, used in acidulating Sherbet, in Persia. By EDWARD TURNER, M. D. F. R. S. E. Professor of Chemistry in the University of London. Communicated by the Author.

OUR intelligent young friend, and former pupil, Lieutenant Alexander, in his lately published Travels from India to England, a work highly creditable to him as a writer and observer, says, " The road to Dalkee is exceedingly stony; and, at eight miles from it, is a capital sporting tract, with a date jungle and swamp on the left. We were here assailed by an insufferable sulphureous effluvium, shortly after we crossed, from several naphtha and sulphureous streams, which issued from the hills, round the bases of which the road winds. At the fountain head the water is lukewarm. The streams have, on their margin, a whitish-grey earth, which is of an acid and saltish taste; it is termed *Gil-i-toorsch,* or Sour Clay. The taste is probably occasioned by a mixture of alum and sal ammoniac. It is used in acidulating sherbet. I brought away a small quantity of this substance for my esteemed preceptor Professor Jameson *."

Some time ago, the specimen of gil-i-toorsch was sent to me by Lieutenant Alexander. I requested my friend Dr Turner to analyze it, and the following is the Doctor's report :—" The gil-i-toorsh consists partly of a coarse earthy powder, and partly of irregular grains, of about the size of a pea. The interior of the latter is of a white colour, as described by Mr Alexander, but the surface of the particles is brown. This colour is owing to iron; for the earth has been kept in a vessel of tinned iron, which is strongly corroded. The earth is slightly moist, and has a sour and inky taste. With distilled water, it yields a solution containing a considerable quantity of free sulphuric acid and sulphate of iron. With nitrate of silver, it gives scarcely a trace of muriatic acid, and it is almost equally free from alumina. It does not, therefore, contain either sal ammoniac or alum. By the action of pure potash, a trace of ammonia was detected. The earthy matter contains some silica; but its chief constituent, especially of the larger grains, is sulphate of lime, some of which

* Travels from India to England, comprehending a visit to the Birman empire, by James E. Alexander, Lieutenant in his Majesty's 13th Light Dragoons. 4to. Parry & Allen, London 1827.

is distinctly crystalline. It emits a faint but distinct odour of sulphur, when moderately heated. Considering the use to which the gil-i-toorsch is applied, I presume all the iron found in the specimen sent to me, must be derived from the box which contained it. I therefore infer, that it consisted originally of sulphate of lime, with a little siliceous matter, acidulated by free sulphuric acid. This acid can scarcely have originated in the decomposition of metallic sulphurets, but must, I apprehend, have been derived from the combustion of sulphur. The sulphureous vapour noticed in the vicinity of the earth, confirms this opinion."

Account of Excavations made at Pompeii from December 1826 *to August* 1827. By T. C. Ramage, Esq. Communicated by the Author.

It was in the autumn of 1825 that I first paid a visit to Pompeii, and the impression it then made on my mind was by no means equal to what I had expected. I returned, however, several times, and found that every examination only increased my desire to investigate it more minutely. You are aware that Pompeii is about fourteen miles from Naples, and five from the crater of Vesuvius. Through it ran the Via Consularis, a branch of the Via Appia, which, striking off from Capua, passed through Naples and Pompeii to Solerno. On entering the suburbs you set your foot on this ancient road, which, like all the other Roman ways, is composed of large unhewn blocks of stone. In Pompeii the pavement has been composed of lava, and shews that Vesuvius must have been a volcanic mountain in some early period of the world, though history has left us no account of it. Alighting at the barrier, where a guard is placed, you enter its suburbs, which have been called Augustus Felix, and appear to have been founded by the colonies of Sylla and Augustus, whose names have been discovered on many of the monuments. One single villa has been completely excavated, and many others no doubt surround it, which will hereafter be exposed to view. The first coup d'œil is remarkably striking, and well-fitted to make an impression on the mind; you see at once the whole length of the street, which is lined on both sides by

tombs, some entire, and some in ruins. They are chaste in decoration, classical in design, and prove that they must have been erected before the taste of the Romans had become corrupted by the love of magnificence and grandeur, which they carried even to the grave. There rest whole families in eternal repose, as if they were still enjoying themselves around their Penates, and solemnising some of those annual ceremonies in which all took a part. The mother is there stretched at the side of the father, and the children, according to their several ages, in regular order beside the mother.

Some of the tombs are most magnificent, and have been erected by a grateful country to citizens whose merits had entitled them to such a distinction; they are adorned with the palm and the laurel, and present the elegant forms of the lectisternium and bisellium. These noble monuments may be considered as altars erected by the Genius of Arts to the honour of Mystery and Death.

It was here that the inhabitants enjoyed themselves at even under the shade of the cypress, which waved its mournful head over the tombs of their ancestors; it was here that they caught those genial breezes, which were so grateful after the heats of the day. What a strange contrast must their games, diversions, and tumultuous joy, have formed to the calm and silence which reigned in the graves where slept those who had once been as gay and as merry as themselves!

But as you have most probably seen a detailed account of the discoveries made previous to December 1826, I proceed now to give a short view of the progress that has been lately made in disinterring the ancient city of Pompeii from December 1826 to August 1827.

At present there is every appearance that we have at last advanced to a part of the town occupied by the more opulent class of citizens, and we are in hope of making some valuable acquisitions to our stock of antiquities. The streets have become more spacious, and the houses begin to have an air of splendour and neatness, far exceeding that of the houses situated along the sea coast. Indeed, as we know that the shops and taverns must have been in the vicinity of the Forum and public

buildings, and as these are almost the only edifices that have been as yet uncovered, we may conclude that the private villas are still concealed from our view. The articles that have been found in these houses are generally superior, both in richness of material and beauty of workmanship, to any that the Royal Museum has yet acquired, and display in a very remarkable manner the labour and ingenuity bestowed by the Romans even on their commonest utensils.

The excavations have taken place principally in two directions,—in that street which is called the Street of the Arch, and towards the angle of the Forum, opposite the Basilica. In the winding lane which leads to the portico of the theatre, there have been several small houses excavated, exhibiting a considerable degree of ingenuity in the just arrangement, and agreeable union of all parts of the edifice, and a most extraordinary economy in the employment of ground. It may indeed be affirmed of them, what Pomponius Atticus said of some old houses he possessed in Rome, that there had been more ingenuity than money expended in their erection. One cannot help admiring the solidity with which many parts have been built, and the beauty of the *opus reticulatum*, which is equal even to the celebrated specimens of this sort of work in the gardens of Sallust at Rome. Here also, were found several Ionic chapters, of a style purely Grecian, which you know is a very unusual occurrence in Pompeii. Their volute resembles the calyx of a flower, attached to its stem, which, turning downwards at the point, where the junction of the volute takes place, winds round the higher part of the shaft of the pillar,—an elegant device, quite new to us.

In the street of the Arch, the houses are larger and more splendid. One of them has its front decorated with representations of baskets, carved in a greyish coloured volcanic tufa, called by the Italians Tufo of Nocera, from the quarries being discovered in the vicinity of that town. These baskets, exhibiting great accuracy of outline, are still in some parts covered with the stucco, which had been applied to them to furnish moulds for others intended to imitate the tufa. The cornice, formed of the same material, is lying on the ground, and furnishes a beautiful specimen of elegance in architectural disposi-

tion. On entering this house, we look across the atrium and the summer parlour. At the bottom of the peristylium, there is a fountain encrusted with shells and glass mosaic, similar to the one excavated some time ago. Near the outer door there is a small staircase, leading to the upper storey, or rather to the roof, as its diminutive size prevents us from supposing the architect could intend it for any nobler purpose. The atrium is Tuscan, painted grotesquely with little flying figures on a red ground: among them the most remarkable are the figure of a winged female, with a garland of flowers in one hand, and a young boy in her arms; a little figure of a female in flowing drapery, with a palm branch in her hand; and a harp-player seated at her instrument. In the summer parlour, enriched by a beautiful mosaic pavement, the walls are ornamented with a variety of fruit and richly plumed birds. The portico, furnished with only two rows of pillars, has on the opposite walls a representation of the same number of columns, corresponding with the real ones, and between them there are landscapes sketched with great spirit, and of a much larger size than any hitherto discovered. These are chiefly views taken on the sea-coast. On the left appears a large harbour, with several vessels at anchor: there is a building erected on a small island, united to the adjoining land by a singular bridge, which is approached by means of a stair, removeable like a draw-bridge. In front is seen a two-oared bark, with sails exactly similar to those used at present in the Bay of Naples. At the side of this there is a building constructed on some rocks in the middle of the water, with a fisherman seated, and in the act of drawing his net. Among many other sketches there is one of a man on horseback, followed by a large dog, and wearing a hat which bears a considerable resemblance to those pointed ones which the peasants of Campania have at present. In the centre of the colonnade opposite the door, there is a fountain, in the form of a small altar, with its niche and top richly decorated with mosaic and shells. In the middle of the semicircular basin of this fountain, there was found, on a round pedestal, a little winged boy of bronze, with one hand raised, and embracing with the other a goose, which was in the act of flapping with its wings, and ejecting a stream of water into the basin. Towards the centre of

the niche there is in the wall a scenic mask, from the mouth of which flowed another jet of water; and on the edge of the basin there was found another statue of bronze, three palms high, representing a fisherman seated with a small basket of fish in one hand, and extending the other, in the act of raising the net. From a rock completely encrusted with shells, on which the fisherman is seated, another jet of water has evidently been thrown. The features of this little figure are strongly marked, and full of expression. Besides a Caryatides of marble, there was found another figure of the same material, representing a young fisherman asleep, and covered with a sailor's mantle, such as is generally worn by the fishermen of the present day. The remains of the leaden pipes, with their stop-cocks, are plainly seen. In this house there was also discovered a beautiful marble table, of Greek workmanship.

Many rich candelabra, bracelets, rings, ear-rings, and medals have been the reward of these excavations. But the most curious discovery of all is that of two glass vases, one of which contained olives, with the oil in which they had been placed eighteen centuries before; and the other nothing but pure oil. It may not be uninteresting to give the chemical analysis of these substances by Professor Covelli of Naples.

Analysis by Professor Covelli.

The olives were found in a quadrangular glass vase, with a large mouth. The oily substance was inclosed in a cylindrical glass vase, with a narrow neck, and a small handle.

Examination of the Olives.—The upper half of the vase containing the olives, was full of volcanic ashes and pebbles; the olives, mixed with a kind of buttery substance, occupied the lower half. They have the form and size of that variety commonly called Spanish Olives; some of them have even still their *pedunculus* or flower-stalk. The kernels are less oblong than those of the Neapolitan species, and also more swollen; the longitudinal streaks are more strongly marked. Their colour is black, but mixed with small particles of a greenish matter, which, with the aid of a powerful lens, it was discovered were those lichens produced on organic substances in a state of putrefaction; but these little plants were not observable at the mo-

ment of their discovery, and have no doubt arisen from the action of the air, which in a few hours had produced such an alteration in their superficies, as had not been accomplished by the influence of so many centuries. This is a proof that these olives, gathered eighteen centuries before by the subjects of Titus, are as fresh and sweet as those produced by Francis I. Indeed, these ancient olives are still soft and pulpy; they have a strong rancid smell, a greasy taste, and leave upon the tongue an astringent and sharp sensation. They are so light, that they swim upon water; the pericardium or seed-vessel shews still its organic texture, though the parenchyma is in that state of alteration which the maceration of a few months usually produces. The kernels are still hard, and so much so that a knife can scarcely penetrate them. The oily part of the parenchyma, though in very small quantities, when analysed carefully in the usual method, has been found to be changed entirely into oleic and margaric acids, which are the fundamental principles of the fixed oils, acidified by oxygen, and form the basis of our soaps. These changes happen generally in oils exposed for some time to the air. This proves that the action of eighteen centuries, which has left untouched the fundamental principles of the oil, has effected no greater change than what is produced by a few months.

The kind of oily substance in which the olives are enveloped, is of a brownish-yellow colour, soft like butter, has a strong rancid smell, soils paper like fixed oils and greasy substances, is melted by a moderate heat (60° or 70° cent.) warmed on a leaf of platina; it burns with a beautiful white flame, without leaving any thing but small white flaky ashes, so light that the smallest puff disperses them. With the alkalies it forms soap; distilled in close vessels, it gives out carburetted hydrogen gas, acetic acid, carbonic acid, carbonic acid gas, and a residue of carbon. This buttery substance, tried by Cheuvreul's method, is found to be composed of oleic acid in large quantities, a small portion of margaric acid, and a substance analogous to the sweet principle of fixed oils, but which differs in many respects, and which may be a new production; and, lastly, an earthy substance, in very small quantities, arising from the volcanic ashes which filled the upper half of the vase

Examination of the Buttery Substance found in the narrow-necked Vase.—This substance is much softer than the preceding: it has a yellowish-green colour, has a strong rancid smell, and exhibits in the mass a number of brown globules, similar to the spawn of fish, but which cannot be made out even by a powerful lens. This substance resembles that found with the olives: it is composed of the same principles, though it may contain a larger quantity of oleic acid, and of that unknown substance analogous to the sweet principle of fixed oils. It appears, indeed, to have been nothing else but the oil of olives, containing some vegetable salt.

Sketch of the Natural History of the Salmo Salar, or Common Salmon. 1. Of the Process of Spawning, and subsequent evolution of the ova; 2. Of the growth and movements of the Young Brood, to and from the sea during the first year of life; and, 3. Of the migrations of the Salmon betwixt the River and the Sea. By DANIEL ELLIS, Esq. F. R. S. E., &c.*

SINCE the year 1824, a Committee of the House of Commons has been employed, during several sessions, in making inquiries into the present state of the salmon fisheries through the United Kingdom. The Committee, in a great degree, originated from numerous petitions presented to the House from Scotland. To gain the necessary information, they, in the first place, prepared and distributed certain queries regarding the present state of the fisheries in the several rivers, estuaries, and adjacent seas; the laws, usages, or regulations acted on, or applicable to these fisheries; the extent to which the law is or can be enforced, and the customs and practices which oppose or counteract it; the *modes* of salmon-fishing now in use; and the actual day on which it commences and ceases in each fishery; at what periods of the year it ought to commence and cease, so as to obtain the greatest supply of good salmon, and preserve most effectually the breed; whether these periods should be the same for all

* Drawn up from the evidence contained in two Reports of a "Select Committee of the House of Commons, on the Salmon Fisheries of the United Kingdom." Ordered by the House to be printed in 1824 and 1825.

rivers, estuaries, &c. or should vary in different rivers; and, lastly, what regulations can best provide for the safety of the parent fish during the breeding season; protect the spawn after its deposition; and finally secure the descent of the young fry down the rivers to the sea.

The answers returned to these queries enabled the Committee to summon before them persons from all parts of the kingdom, the best qualified to give the desired information; and the evidence collected is contained in the above mentioned Reports. This evidence goes to prove, that the productiveness of the salmon fisheries has *decreased*, and is *decreasing*, in almost all the rivers in the United Kingdom; but that this decrease arises, not so much from any changes in the habits of the fish, or in the condition and circumstances of our rivers, as from the operation of injudicious laws in relation both to the times and modes of fishing; from the prevalence of most destructive practices, and incredible abuses in almost all our rivers; and from the indulgence of a too greedy spirit of gain, which, instead of waiting for the natural production of the golden egg, cuts up at once the animal that can only daily produce it. The facts brought out in these Reports, respecting the natural history of the salmon, particularly as regards the propagation of the race, their rate of growth, and their several migrations between the rivers and the sea, are far more complete than any we before possessed; and, as they are not only curious in themselves, but of the utmost importance in any legislative measures that may be adopted for the future regulation of the salmon fisheries, I have thought that the collection and arrangement of them would form no unsuitable article for the Philosophical Journal, and perhaps prove acceptable to many of your general readers.

Naturalists enumerate several species of the genus Salmo, of which a distinguished zoologist, Dr Fleming, mentions seven as met with in the estuary of the Tay *. These are,

1. Salmo salar, or Common Salmon.
2. Salmo hucho, or Bull Trout.
3. Salmo eriox, the Gray or Shewn.
4. Salmo trutta, or Sea Trout.
5. Salmo albus, the Whiteling or Finnock.
6. Salmo fario, or River Trout.
7. Salmo eperlanus, the Spirlin or Smelt.

* Report II. p. 63.

On the present occasion, it is proposed to speak only of the first species, viz. the Salmo salar, or common salmon; and this we shall do, by treating, 1*st*, Of the process of spawning, and subsequent evolution of the ova; 2*d*, Of the growth and movements of the young brood to and from the sea, during the first year of life; and, 3*d*, Of the migrations of the salmon betwixt the river and the sea.

Of the process of Spawning, and subsequent evolution of the Ova.

The salmon is a very prolific animal. Both the male and female frequently propagate their kind during the first year of their age; while the older fishes, which inhabit alternately the seas and *lower* parts of rivers during the winter and spring months, ascend to the *higher* parts of rivers in autumn to exercise the same function. Early in spring the milt, or reproductive organ, appears to be forming in the male and the roe in the female salmon, but both are then small in size; they increase in each sex through the summer months, and towards autumn the male and female become respectively full of milt and roe. In proportion as these bodies advance to ripeness, the salmon fall off in condition. Before the spawn is of great size, the belly of the fish, says Dr Fleming, is loaded with fat; but when the milt and roe have become ripe, that fat has disappeared from the belly, and it is little else but skin. This change furnishes a test by which we may know whether a *kippered* salmon had been in good or bad condition at the time it was so prepared; for the thinner the edges of the belly may be, the presumption is, that the nearer was the fish to a spawning state*.

In a general way, the evidence obtained from all parts of the United Kingdom goes to prove that, towards the months of August, September, and October, the reproductive organs, both in the male and female salmon, have, more or less, completely reached maturity, at which period the roe in the female is found, on the average, to contain from 17,000 to 20,000 ova or eggs. When arrived at this state, the instinct of propagation impels them eagerly to seek rivers, and to ascend nearly to their sources, in order to find a place suitable for the deposition of their spawn.

* Report K. p. 72.

They no longer, as in the winter and spring months, roam over the coasts and shores, and return backwards and forwards with the flowing and ebbing of the tide, but pursue the most direct route by the mid-channel up the river, and make the greatest efforts to overcome every obstacle, either natural or artificial, that may impede or obstruct their course. " I have often seen them leap a fall, near my residence," says Sir G. S. Mackenzie, " of about 30 feet high, but they seldom spring out of the water more than 8 or 10 feet. I have seen them leap over a dry rock of considerable height, and drop into the water behind it. After having entered a river, the object of salmon appears to be to push as far up towards the source as possible, in order that they may deposit their spawn in the small streams that form their sources; and which, on account of their being near the springs which supply them, are neither so apt to run dry as the river lower down, where the effect of evaporation is greater, nor to be so affected by frost as to stop the water from running. The water is always steadier in its temperature near the sources, varying little throughout the whole year; and these small streams are fitted peculiarly for vivifying the spawn, as they form a constant succession of rills, by which the water is kept fully saturated with air *." It is not always, however, that the spawning fish are able to reach these sources, but are obliged to deposit their spawn in the shallow fords in the beds of rivers, and sometimes in the streamlets of mill-dams.

The process of spawning itself has been observed with much accuracy by Mr Halliday in the river Annan in Scotland, and by Mr Little in the Bann in Ireland. It is principally accomplished in the months of November, December, and January. According to Mr Halliday, when the parent fishes have reached the spawning ground, they proceed to the shallow water, generally in the morning, or at twilight in the evening, where they play round the ground two of them together. After a time they begin to make a furrow by working up the gravel with their noses rather against the stream, as a salmon cannot work with his head down the stream, for the water going then into his gills the wrong way, drowns him. When the furrow is made, the male and female retire to a little distance, one to the one

* Report I. Appendix, p. 17.

side and the other to the other side of the furrow: They then throw themselves on their sides, again come together, and, rubbing against each other, both shed their spawn into the furrow at the same time. This process is not completed at once: It requires from 8 to 12 days for them to lay all their spawn, and when they have done they betake themselves to the pools to recruit themselves. He has seen three pairs on a spawning bed at one time, and stood and looked at them while making the furrow and laying the spawn *.

The account given of the same process by Mr Little, agrees with that just stated. He observes that the spawning commences in November in most rivers, and is continued through December and January; that, when a pair of salmon are about to spawn, they make a furrow in the shallow part or current of the water into which the spawn is deposited, so that they work against the stream, increasing the number of furrows, until they have formed a bed of perhaps 12 feet by 8 or 10; the bed being at first very little, but enlarging every day. He observed the salmon to go leisurely down the side of the bed, and, turning round at the place where they had thrown up the gravel, come back to that point next the stream; they then threw themselves on their sides in the manner previously described, depositing their spawn in the furrow as they moved upward, and, at the same time, covering it over with the gravel as they went along. In this manner they continued working for several days till they completed their bed; and if it so happened that they were frightened, they would swim away, and in a little time return to it again; or, in some instances, would desert it altogether, and begin at another place †. Dr Fleming has never himself seen the process of spawning so completely as to be able to describe it minutely; but he is satisfied that the description given by Messrs Little and Halliday is accurate. Notwithstanding the number of eggs to be deposited, they must, he adds, be excluded one by one, which accounts for the long continuance of the process; and if, during the act of spawning, the male fish be destroyed, the female leaves the bed, and in the deep pools endeavours to find another male ‡.

* Report I. p 61–2. † Ibid. I. p. 108.
‡ Ibid II. p. 66.

In the statement of Mr Little, both the male and female fish are said to assist in forming the bed; and Mr Halliday has often taken these fish, on their return to the sea, with the skin rubbed off below the jaws, of the size of a half-crown piece, occasioned by rubbing up the gravel and making furrows for the spawn *. At this particular period, the head of the male has been said to be furnished with a long hard bill on his under jaw, and which again decreases as the spawning season passes off. This bill or hook has been deemed by some an extraordinary provision of nature, to enable the male more effectually to aid in preparing the furrow destined to receive the spawn. But Dr Fleming says it is the under jaw itself of the male that is thus turned up; that it appears to be a distinguishing mark of sex, and not produced by any mechanical means †.

The spawn is, as we have said, deposited in furrows formed in the gravel, and is afterwards covered over with loose gravel, so as to resemble, says Mr Little, an onion bed in a garden. In this state the ova remain for weeks, or sometimes much longer, apparently inert, like seeds buried in the soil. The period at which the young fry begin to rise, depends much on the season of the year. They remain in the bed, says Mr Little, till some natural warmth comes into the river in the spring of the year. In an early spring the fry come forth early, and later when the spring is late. Generally they begin to rise from the bed about the beginning of March, and their first movement is usually completed by the middle of April. Mr Little has never himself seen the first appearance of the beds after evolution has commenced, and previously to the fry quitting them; but persons employed by him to protect the beds in the upper branches of the rivers, describe the young animals as rising from the beds like a crop of oats or thick braird of grain, rushing up in very great numbers. The tail first rises up, and the young animals often leave the bed with a portion of the investing membrane of the ovum about their heads ‡. Mr Halliday states also, that the fry generally come first into life from about the 10th of March to the 10th of April. They do not all, however, come into life exactly at one time, but nearly so, and some appear to

* Report I. p. 62. † Ibid II. p. 67.
‡ Ibid p. 109.

be much larger than others. He, too, has seen them, when disengaged from the spawning beds, with a portion of the skin of the ovum sticking to their nose like a scale *.

During the winter 1824, Mr Hogarth jun. observed frequently the spawning beds in the River Don, and had the spawn taken from them occasionally to examine the state it was in, and found it advancing gradually. The first particular change observed in the roe, was the appearance of two black specks. In this state, a portion of it was taken up and put into phial bottles; and, by supplying these with frequent changes of fresh water, many of the ova came into life. The young animals lived in the bottles, and appeared very vigorous for about three weeks, the water being frequently changed. After this, they became restless and uneasy, would not eat, and died when they had attained the length of an inch. He procured an artist to make sketches of the appearances exhibited by the ovum in the successive stages of its evolution, as represented in Plate III. When a portion of the roe was put into *salt* water, none of the ova ever came into life; and when a young fish, that had been hatched in fresh water, was put into salt water, it shewed symptoms of uneasiness, and died in a few hours. Whence it is inferred, that the spawn of salmon, if deposited in the sea, would not be evolved; neither would the young fish, in the earliest periods of its life, be able to exist there. †

SECT. II. *Of the Descent of the Fry to the Sea, and of their subsequent growth and movements.*

Having thus described the process of spawning, and traced the series of changes exhibited in the evolution of the ovum, we have next to follow the progressive movements of the young fry from the place of their birth in the river, to their arrival in the ocean. When their evolution is completed, and they have disengaged themselves from the spawning beds, they keep at first in the eddy pools till they gain strength, and then prepare to go down the river, keeping, says Mr Little, near to its sides, and proceeding on their way till they meet with the salt water,

* Report I. p. 62.

† Report II. p. 92.

when they disappear. * Whether the river be early or late, the descent of the fry is made much about the same time in all. It begins in the month of March, continues through April and part of May, and sometimes even to June. † Mr Halliday also describes the fry as making towards the edges of the river soon after their birth, and keeping in the easy fresh water about its sides: afterwards, as they become stronger, they go more towards the mid-stream; and, when the water is swelled by a little rain, they move gradually down the river. On meeting the tide, they remain for two or three days in that part where the water becomes a little brackish from the mixture of salt water, till their constitutions become inured to the change, when they go off to sea all at once, sinking down in the bed or channel in the middle ‡. From the end of March till the middle of May, he has seen them thus descending; and, in particularly dry seasons, when no floods occur, they sometimes could not get down for want of water until the month of June §.

That the young fry descend rivers at the times and in the manner above stated, is proved by the evidence of various witnesses, and more especially by Messrs Shepherd and Sime. To ascertain the precise course of their descent, both in rivers and in their estuaries, Messrs Shepherd and Sime were many years ago specially appointed, under legal authority, to examine the river and estuary of the Tay, by going up the said estuary and river in the month of April, when the fry were descending, till they should find the fry, and see them distinctly making their way downwards. They accordingly proceeded up both sides of the Frith, from one end to the other, but could there meet with no salmon fry between high and low water mark. A little above a place called Carpow-bank, however, where the frith appears to begin, they met with the fry at the sides of the river, where they disappeared in the deep water, and where, with a small net, they caught many of them in the very middle of the channel. Above this point, and all the way upward to Perth, the fry were visible to the eye along the sides

* Report I. p. 109.
† Ibid. p. 62.
‡ Ibid. p. 115.
§ Ibid. p. 63.

of the river.* The reason why the fry thus descend by the margin in rivers, and by the mid-channel in estuaries, is apparently, says Dr Fleming, because the margin of the river is the easy water, and consequently best suited to their young and weak state: but when they reach the estuary or tideway, then the margin of the water being there most disturbed, the fry avoid it, and betake themselves to the deepest part of the channel, disappearing alike from observation and capture, and so go out to sea. Hence they are never seen in the pools on the banks of the estuary, nor caught in any of the nets used there in taking the small fish †.

The young fry, at this period of their growth, are called sometimes Smolts or Samlets. They are of very different size and weight, according to their age, varying from half an ounce to two or more ounces. As they are never seen or taken by salmon fishers after they enter the sea, it is probable, says Dr Fleming, that they go into deep water at a distance from the shore.

After remaining some weeks in the sea, the samlet returns to the coasts and rivers, and is sometimes seen as early as May in some rivers, being then about a pound or a pound and a half in weight; in Scotland it is then termed a Grilse. The grilses seldom, says Mr Little, appear till nearly the middle of June, and weigh then from two to two and a half or three pounds, increasing in size half a pound a week. By the end of the fishing season, they weigh from seven to nine pounds‡. In the river Severn, they are said to return from the sea towards the end of June or beginning of July, weighing then from two and a half to three pounds, rarely four pounds; but by the end of August, says Mr Ellis, they have grown so large as to weigh from four to eight pounds §. At this stage of growth they are called Botchers; of these, some of the larger ones go up the river to spawn*; others are considered to return to the sea, and come up again the next spring of the year ||; they then weigh from ten to fifteen pounds, when they take the name of Gillings.

Many experienced fishers, examined by the Committee, consider the grilse as a fish altogether of a different species from the salmon, while others regard it as the samlet in its progress to

* Report I. p. 93. † Ibid. p. 111, 112. ‡ Ibid.
§ Ibid. II. Appen. p. 13. || Ibid.

form the salmon. At the commencement of the grilse season, only small ones are taken, which increase gradually to the weight of seven or eight pounds. Now, were the grilse a distinct species, we might, says Dr Fleming, expect to meet with some of them the following year as old fish, weighing nine or ten pounds, whereas, we get them only of small size, from one and a half to two or more pounds *. To ascertain the fact by experiment, Mr G. Hogarth jun. in the month of May 1824, when the samlets were going down the river Don, caused a number of them to be taken and marked by cutting off the *mort* or dead fin. In the course of the month of July, several grilses were taken without that fin; whence he inferred, that they were some of the fishes he had previously marked. Not only did samlets thus become grilses in a few weeks, but, in the following year (1825), he got three salmon, marked in the same way, which he also considered to be some of those individuals he had marked originally as samlets. Farther, in the month of September in the year 1824, he caught ten or twelve grilses, which were put into a salt water pond. Owing to some very high tides that season, some of these fish made their escape, but there were three still alive in May of the following year. These he had taken out and examined in the presence of many competent judges, who all were decidedly of opinion that they were real salmon. † These experiments confirm the statements already made, proving not only the growth of the smolt or samlet into the grilse or botcher, but also that of the grilse into the gilling or salmon of one year's growth.

With respect to the subsequent growth of the salmon, it is considered that, in the river Severn, the young salmon, which, in the spring of the year, weighs from ten to fifteen pounds, has increased, in the following months of December and January, to eighteen and twenty-five pounds, and in another year would attain the weight of thirty-five or forty pounds, which is as large as they are now ever taken in that river. It is not doubted, however, that if they escaped the nets of the fishers, they would grow to a still greater size, a salmon having heretofore been taken which weighed fifty-two pounds when *out* of season; and which would doubtless have been of greater weight had he been taken while in the condition of a clean fish. In the river Lee in Ireland,

* Report II. p. 92.

† Report II. Appen. p. 13.

Mr G. Shepherd also states, that the grilses, or peels, as they are there called, which retreat to the sea, weighing from eight to ten pounds, make their reappearance in the river during the following autumn, weighing from twenty-four to thirty, or even thirty-four pounds *.

Were we entitled from these facts and statements to estimate the rate of growth of the salmon from birth to the maturest state in which it comes to our tables, we might perhaps say, that, in the first five months of its existence, that is, from April to August, both inclusive, it reaches, in favourable circumstances, to about eight pounds in weight, or grows at the average rate of about one pound nine and a-half ounces per month: that, from September following to March, seven months, it acquires seven pounds additional weight, or one pound per month: that, from April following to December, or nine months, it gains ten pounds additional weight, which is at the average rate of about one pound one and three-fourth ounces per month: and, lastly, that, through the next twelve months, it gains ten pounds more, or weighs thirty-five pounds, which is somewhat more than thirteen one-fourth ounces per month. According to this calculation, the rate of growth is greatest in the first period, diminishes as the age increases, and is about one-half ere the salmon has attained to the third year of his age; and by dividing the total weights by the total months, it will be found that the salmon acquires a weight of about thirty-five pounds in thirty-three months, which, on an average of the whole period, is nearly at the rate of one pound one ounce per month. We give this only as an approximation to the truth; for the *data* assumed, both as to the periods of time taken, and the actual weights of the salmon at those periods, may not be the most correct; and, regarded as an inference generally applicable, much variation in the result may exist in reference to salmon taken in different rivers, and even in the same rivers, under circumstances that vary the period of their birth, or their facilities in getting to the sea, where alone they seem able to procure a due supply of food. Experiments, like those described by Mr Hogarth in the preceding paragraph, if sufficiently extended and varied, and made with all the requisite accuracy as to dates and weights, and with due care to identify and distinguish the individual fishes experimented upon, would

* Report II. p 148.

be the best adapted for ascertaining the proportionate rate of growth in these animals.

Unfortunately, however, in the present practice of salmon fishing, experiments of this kind can hardly be continued for a sufficient length of time to obtain the required results. Many of the witnesses state, that the skill and perseverance of the fishers are now so great, that, under the stimulus which ready markets and high prices afford, very few of the clean salmon, which once pass up our rivers, are again permitted to return to the sea; and, consequently, few salmon are now taken of more than one year's growth. In all the fisheries, north of the Tay, with which Mr Hogarth is acquainted, the proportion of grilses to salmon has, for many years past, been gradually increasing; so that, though the total weight of fish taken may not have diminished, the quantity of salmon has, and this deficiency has been compensated for only by the increased weight of grilses. The cause of this decrease in the proportion of salmon is owing, continues Mr Hogarth, to the too assiduous and close manner of fishing, by which both the number and size of salmon have diminished. I am quite satisfied, he adds, that all our rivers are overfished, even those as to which the total weight of fish has increased *. The great proportion of grilses to salmon in some of the Irish rivers, is remarked by Mr Halliday †; and Mr Little states, that, though the total weight of fish in the river Foyle, in Ireland, has much increased, yet it is mostly made up of grilse, it being seldom that any large salmon is taken in it. In the Shannon, the fish are a great deal larger, few of them being under twenty, and many thirty-five or forty pounds, and upwards ‡.

After the process of spawning is completed in the river, the parent fish, says Mr Halliday, retire to the adjoining pools to recruit. In two or three weeks from that time, the male begins to seek his way down the river; the female remains longer about the spawning ground, sometimes until April or May. The fishes which have thus spawned are denominated *kelts*. These kelts, or spent-fish, come down the river, says Dr Fle-

* Report II. p. 104, 109. † Report I. p. 64.
‡ Report I. p. 112.

ning, during the spring months, from February to May inclusive; so that two or three months may intervene between the deposition of the spawn and the descent of the parent fish, varying, probably, according to the degree of strength in the fish to undertake such migration, and the condition of the river in regard to the quantity of water. In their progress to the sea, when they reach the estuary, they pursue a course precisely similar to the fry, not roaming about the banks like clean fish, but keeping in the mid-channel. They are at this time comparatively weak; and, in thus betaking themselves to the deepest parts of the channel, they are better enabled to resist the deranging motion of the flood-tide, and to take advantage of the ebb-tide in accelerating their migration to the sea *.

It would seem, from a fact mentioned by Mr Little, that some of the kelts, which may have gone down in the spring months to the sea, return again in autumn, in breeding condition. He states, that the person, from whom he purchased the fisheries at Dumfries, told him, that he one year marked a great number of kelt-salmon going down to the sea, and they returned to him again that season, in full condition, going up the river to breed *. This rapid recovery of the kelt-salmon, after it reaches the sea, and speedy redevelopement of its reproductive organs, is not more remarkable than the early growth of these animals, and the developement of those organs in them, during the first months of their existence; by which they are enabled, as is testified by many witnesses, either to pair together, or with older fishes, and so to propagate their kind.

These facts, concerning the propagation of the salmon, and the movements and growth of the young fry, are not only interesting in themselves, but derive additional importance from the generality of their occurrence, and their applicability to all the rivers in the United Kingdom, with such modifications only, as local circumstances and conditions may occasionally introduce. Nature has ordained that, in these, as in other animals living in their pristine state, there shall be one season of the year in which the organs of reproduction are fully developed: a second, in which the sexual function shall be discharged: and a third, in which the young progeny shall spring into life, and go through

* Report II. p. 68.

† Report I. Appendix, p. 13.

their destined changes. These periods may be varied, to a certain extent, by accidental circumstances, or the purposes of nature be in some instances entirely frustrated; but such accidental occurrences only partially disturb, but do not counteract, the operation of general laws. In certain seasons, for example, a deficiency of water in any particular river may, in the first instance, prevent the parent fishes from ascending to deposit their spawn, when, by nature, they are prepared to do so; and the proper season for spawning may thus be delayed, or sometimes entirely lost. In other instances, obstacles, either natural or artificial, may oppose the ascent to the spawning grounds; and the female be constrained, as she sometimes is, to discharge the ova in the deep water of rivers, or in the sea, where they are wholly lost. Even when she gains the upper parts of rivers, some time may elapse before she finds a suitable place to deposit the spawn, or a male to impregnate the ova: or the bed, in which the impregnated ova may have been duly deposited, may not retain a suitable quantity of water: or the water itself may become contaminated, and not furnished with air fitted to carry on the evolution of the ova: or, though the water and air be duly supplied, a difference of temperature, arising from season, from elevation above the sea, or from the prevalence of winds, may check the progress of developement, and proportionably retard, in particular rivers and situations, the appearance of the young fry, or even prevent it altogether. Even when the evolution of the ova may have been accomplished in due time and manner, the want of water in rivers, during very dry seasons, may retard their descent to the sea until a later period than usual, or sometimes altogether prevent it.

Making, however, all due allowance for these varying circumstances and their corresponding results, there seem to be some rivers in which the breeding period of the salmon is uniformly earlier than in others. Thus, says Mr Little, the rivers Annan, Esk and Nith, do not afford salmon in perfection until a full month after the Dee, which is adjacent to them; and the salmon caught in the Dee are in bad condition nearly a month sooner than in the other rivers; they are full bellied, and in worse condition. So, likewise, the salmon taken in the river Shannon in Ireland, are in greatest perfection in February,

March and April; and the fishing there is nearly over by the middle of May *. A similar remark is applicable to the Lee, and other rivers in Ireland; to the Eden, Severn, and some others in England; and to the Ness and Thurso in Scotland. This may probably arise from these rivers possessing a higher mean temperature at the season alluded to, the direct operation of heat, in accelerating the developement of the reproductive organs being not less marked and striking in the animal, than it is in the vegetable kingdom.

SECTION 3.—*Of the Migrations of the Salmon betwixt the Rivers and the Sea.*

We have seen, that the brood of the salmon, after a short residence in the sea, return to rivers greatly increased in size. Many practical fishers, those especially connected with river fisheries, contend, that not only the young brood, but the older salmon, always make efforts to revisit their *native* rivers. That many do so is proved by the facts already stated, of salmon, which, having been marked on going down to the sea, have been afterwards retaken in the same river, and identified: But it is equally certain, that numbers of fish, thus previously marked, have never been retaken in their native rivers, but sometimes in another that adjoins it; and when we consider, says Dr Fleming, the numerous foes which unceasingly persecute the salmon during its abode in the sea, which must necessarily mix the families or tribes belonging to different estuaries and rivers, it seems difficult to conceive, how, after such intermixture, the breeds of different rivers could again separate and collect into their original groups †. The assertion made by several experienced witnesses, that they can discriminate the salmon of different rivers by original peculiarities of form, may be met by that of others, equally experienced, Mr Halliday for example, who denies that any such distinction is practicable. That salmon, however, do frequently differ considerably in point of form from one another I have repeatedly witnessed, says Dr Fleming, by looking at the fish taken at the same place by the same net, and collected together in a boat; but these variations are not greater than in other species of animals, subject to variations

* Report I. p. 114.

† Report II. p. 70.

in the place of their residence, and in the quantities and qualities of their food *.

The migration of the salmon from the sea to the river, and back again from the river to the sea, would seem, in certain rivers, to take place at short intervals, through every period of the year. During all the spring and summer months, says Mr Little, salmon continue to visit the rivers from the sea. When they thus enter the river early, they would soon go back if they were not killed. After being some little time in the river, they would naturally return to the sea as soon as there was a little flood. He has known them taken in the river Annan when thus going down again to the sea †;—a fact confirmed by Mr Halliday, in the most distinct terms. He fished the river Annan for several years; and states, that there is one pool in particular in that river, which he had often fished, quite clean *before* rain came on; yet, whenever the rain did come, he continued fishing till the water rose so high as to stop the operation; and all the time he caught salmon coming down the river, some of them much exhausted, and quite changed in colour, as if they had been hung in a smoky chimney, and others very red in the skin. He has taken more than a hundred fish, in one night, in that pool, after the rain had commenced, although it had been fished clean immediately before ‡.

But, though the disposition in salmon to enter rivers, at short intervals, may be universally the same under similar circumstances; yet the fact, that they are found in different rivers, at different times, seems to point to some differences in the circumstances and conditions of those rivers, which counteract these natural dispositions. Thus, in the rivers Ness and Thurso in Scotland; in the Severn, the Eden, and others in England; and in the Shannon and Lee in Ireland, the months of December, January, and particularly February, are declared, by various witnesses, to be the best times in which salmon are taken in those rivers, both in regard to the quantity and quality of the fish; and some of these rivers begin to fall off after this period, and, towards April and May, yield few or no fish. Other rivers again, as the Tay and the Tweed, do not yield fish so soon as the former, but continue to afford them, in a marketable condi-

* Report II. p. 70. † Report I. p. 108

‡ Ibid. p. 61.

tion, till September; and others are said not to repay the expence of fishing them till March, or even April, and to yield the best fish in May and June.

This difference of time, in the appearance of the salmon in different rivers, cannot be ascribed to any difference in geographical position, as far as regards these islands; for the Ness, which is one of the earliest rivers in Britain, is situate in the highest latitude. It must therefore be sought for in some local circumstances and conditions, which more or less adapt particular rivers to the taste and habits of the fish. Now, the Ness, we are told, flows out of a lake of great depth, which never freezes. In the year 1807, Mr Alexander Fraser states, that, at Inverness, the temperature, for ten days, was from 23° to 30°, or more, below the freezing point; yet this intense cold made no impression either on the river or the lake; and clean fish, he adds, pass up the Ness every month in the year, except May and June *. It is probable, therefore, that the comparatively high temperature of the Ness, during the winter months, induces salmon to enter it at a time when they are repelled from other rivers, which, either from their shallowness, or from receiving large quantities of water produced by the melting of snow, are reduced to a temperature unsuited to the economy and habits of the fish. It is well known, says Sir G. Mackenzie, that, while snow is melting on the mountains, few fish go up rivers. Whether it be its coldness, or any other cause, that makes them dislike snow water, I cannot tell; but the fact has been noticed, and is consistent with my own observation †.

As these fishes seem thus to decline entering rivers when much reduced in temperature, so, at other seasons, they seem equally to avoid them when their temperature is too high. During the summer season, the water, in many rivers, becomes so small, and gets so hot, that the salmon will not enter them, but linger upon the coasts, and about the mouth of the river. In one very dry and warm season, when stake-nets were in use in the estuary of the Tay, the salmon, says Mr Halliday, did not even approach the highest stake-net during the neap-tides; but, when the spring-tides became high, the fish then came up to those nets, and were taken; when, again, these latter tides fell off, the nets on the lower parts of the frith caught a great

* Report II. p. 43.

† Report I. Appendix, p. 17.

deal more fish, which did not then float up so high as the upper nets *. Many other witnesses give a similar testimony, as to the refusal of salmon to enter rivers when much heated. The temperature of the sea is probably that best suited to the economy of these animals; and those rivers, therefore, which come nearest to that temperature, will probably be preferred by them; and as the ordinary heat of fishes is very near to that of the medium in which they live, a temperature, either much above or below that of the sea, is, in all likelihood, unsuited to their nature.

If, however, freshes and floods occur in any particular river during the hot season, salmon then move up them, even many months before the spawning season. Some of these may remain in the upper parts of rivers, if they find water sufficient to harbour and protect them, until that season arrives; but others, as we have seen, avail themselves of subsequent floods to revisit the sea, in which alone they may be said to thrive. It is not, however, the freshes and floods in all rivers that induce salmon to enter them; for sometimes the water brought down certain rivers, is impregnated with matter disagreeable to the fish. The rivers Ness, Ewes, Shin, and Thurso, says Mr Stevenson, supply the earliest fish in Scotland: the Tweed and Tay also supply early fish, but not so early as the former rivers. Now, the four first rivers are discharged from the largest lakes in Scotland, and in these lakes the water is purified before it is sent down the rivers, in the winter and spring months. So likewise the Tweed and Tay run principally through clayey soils, and their waters, in spring floods, are not impregnated with matter disagreeable to the fish. But rivers which run through a mossy district, and discharge their waters into the sea, without previous purification in large reservoirs or lakes, as the Findhorn, Conon, Beauly, Spey, and many others,—such rivers, when swollen by the melting snows in the spring months, are turbid and disagreeable to the salmon until about the month of April, when they begin to discharge light spring rains, sweet, and comparatively free from the impurities of an earlier period. It is then only, he adds, that these latter rivers begin to yield fish, that is, not till the lake-rivers are beginning to fail; indeed,

* Report I. p. 72.

when the seasons of some of them have been terminated. From observations and facts which have come within his own knowledge, the witness is convinced, that, if an account of the quantities of fish taken at the various fisheries in Scotland, and the exact periods at which they are taken, were obtained, it would be found that all the rivers discharged from lakes, produce fish at an early period of the year; whilst those discharged from a mossy country, do not produce fish until they commence to send down the sweet spring rains. When, therefore, it is supposed that salmon is in season at different periods of the year, in different rivers, the supposition is so far correct: it does not, however, depend upon the state in which the fish is at that period, but on the state the river is in. Salmon are extremely nice, and only go into fresh water when it is exactly to their taste; and when the river is in a state to induce fish to enter it, they are gotten of much finer quality than at a period when they do not enter so readily *. In accordance with these views, another respectable evidence, Mr Moir, states, that salmon will not enter foul water if they can avoid it; in proof of which, a case exactly in point, says he, occurs in this neighbourhood. The bay of Nigg is perhaps the most productive sea-fishery on this coast (Aberdeen), yet, when the river Dee is discoloured by peat-bog water, that water is carried into the bay of Nigg by the flowing of the tide: at such times not a single salmon will enter it, and the fishing is frequently interrupted for several days together from this cause †.

In the migrations of salmon from the sea to the river in the winter and spring months, their course through the estuary seems altogether different from that which they pursue in autumn. In the latter period, impelled by the instinct of propagation, they pursue their route in the most direct way through the mid-channel, rushing up with the greatest eagerness, where there is water sufficient to convey them, and braving all obstacles to their ascent: in the former, they roam over the banks of the estuary and of the mouths of rivers, borne up with the flowing tide as far as it will carry them, and often returning again to the sea with the ebb tide. It is indeed only when thus roaming over the banks that salmon are taken in the estuaries, where

* Report II. p. 121–2.

† Report II. Appendix, p. 173.

stake-nets are employed, these nets being made to extend upon the coasts between high and low water-mark. That salmon move upwards and downwards with the tide, is testified by many witnesses, who have seen and intercepted them in their downward course: and, by the fact, that stake-nets are commonly provided with ebb as well as with flood courts, on purpose to meet this disposition in the salmon, and do actually catch sometimes as many fish in their downward as in their upward course. Hence, too, it is, that when, in autumn, salmon become full of spawn, and desert the coasts, betaking themselves more to the mid-channel, in order to ascend rivers, few are taken in stake-nets; and, for the same reason, as the kelts or spawned fish descend, like the fry in the mid-channel, they are rarely, if ever, intercepted by the stake-nets.

But why, it may be asked, do salmon thus visit the coasts of the sea and of the estuaries of rivers, linger upon them, and seem indifferent about entering rivers, unless they are, in all respects, suited to their taste? To this they are apparently impelled by the strength of the appetite, which, next to that of propagation, exerts the greatest force over the movements of animals, viz. that of hunger. On the banks of estuaries, salmon, says Mr Halliday, find a great deal of food; he has taken a great many salmon in the frith and estuaries with worms passing through them; such worms as are to be seen on those banks*. During the fishing season of 1823, Mr Moir received all the salmon caught in the stake-nets set between the rivers Don and Ythan; also the whole of the fish taken in the bay of Nigg; those taken, likewise, at the bridge of Dee, and at nine other small fisheries in that river. As all these fish were cut up for the purpose of being preserved in a fresh state, he had an opportunity of examining their stomachs. In the stomachs of those taken in the upper river fisheries, he could never detect any kind of food; whereas, those taken in the sea were frequently gorged with food, which was principally sand-eels (*Ammodytes tobianus* of Lin.): The different appearance of the fishes corresponded with that of their stomachs, those taken from the river being softer and inferior to those got from the sea. Whence he concludes, that salmon frequent the flat sands

* Report I. p. 61.

between the Don and Ythan, for the purpose of feeding; and, for the same reason, he adds, they frequent the coasts at Musselburgh and Aberlady, which abound with sand-eels, and are successful stations for the stake-net, though the one place is thirty, and the other forty, miles from a spawning river *.

That salmon do obtain the chief part of their food during their residence in salt water, seems certain from the fact, attested by various persons, that they are in greatest perfection when taken out of the sea, or very shortly thereafter; and that they fall off in condition in proportion to their abode in rivers. Salmon taken in the sea, says Mr Halliday, are by far the richest and best; they are both weightier and fatter, and in firmer condition. If detained in fresh water at any season, they become unsound, and if this happen during the warm weather of summer, they are soon rendered unfit for food †. The largest fish are usually got at sea-fisheries, says Mr Stevenson, and the nearer they are got to the salt water the finer is their quality; so much so, that any one versed in the state of salmon, would at once be able to pick out, from 500 head of fish, those that had been more than two or three days in the river ‡. As it thus appears that the stomach of the salmon is filled with food, and his condition the most perfect, while roaming over the coasts of the sea and the banks of estuaries; and that he is found with an empty stomach, and in very inferior condition, after a short residence in fresh water, we readily see not only why he visits the coasts of the sea, but lingers upon them; why, if he is induced to move upwards with the tide, he again returns with it; and why, when he may have pushed up rivers during floods, he soon tries again to revisit the sea, where alone he is enabled to find proper and sufficient food to satisfy his hunger, and adequately support his growth.

From the facts thus stated respecting the migrations of the salmon, at different periods of its life, it would seem that it can begin to live only in fresh water, and that, in the earliest period of its existence, salt water is fatal to it; that, at a period somewhat later, it descends rivers on its way to the sea, where it increases rapidly in size, and in two or three months returns again to the river.

* Report II. p. 171. † Report I. 79. ‡ Report II. p. 122.

During the summer months, salmon from the sea proceed sometimes high up those rivers, which are furnished with a due supply of water, either permanently, or during occasional floods; and in subsequent floods they try again to return to the sea: at this time of the year, however, their migrations into rivers are often limited to the point to which the tide flows, and they return again to the estuary and sea with the ebb-tide.

In autumn, again, the male and female salmon ascend to the shallow fords and sources of rivers to breed, remaining there during the winter months, the male, however, returning early in the following year, and the female not till March or April.

Beside the breeding-fish, which descend in the winter and early spring months, clean salmon from the sea are constantly ascending and descending those rivers, which, by the quantity, quality, and temperature of their water, are fitted to receive them.

With respect to the *causes* which influence these alternate migrations of salmon, it would appear that they move towards the sea chiefly in search of the food found on its coasts, and on those of estuaries; whilst the chief impulse that urges their movement up rivers, is the propagation of their kind, where alone the spawning process can be duly exercised. As to the cause of their seeking fresh water, when not urged by that impulse, we can offer no other reason than that of a sort of *instinct*, which incites them to remove occasionally into fresh water, in which alone they were at first able to exist; whilst the appetite for food calls them again back to the sea. Perhaps, if the water of rivers were always in sufficient quantity, and perfectly suited to the taste and economy of salmon, they would be moving backwards and forwards from the sea to the river, and from the river to the sea, at intervals more or less great; and, therefore, the different periods in which they appear in different rivers, is owing to the different circumstances and conditions in which those rivers may be, rather than to any natural difference in the economy or habits of the fish. How far they move into the deep sea is not known, but that they roam over the coasts, at great distances from the mouths of rivers, is certain from the fact of their being captured in such situations.

Description of Plate III. exhibiting the Evolution of the Ova of Salmon.

Fig. 1. The ovum of the natural size, after the embryo has become quick in it: at this stage, the body of the embryo has a pinkish tinge, and the eyes are disproportionably large.

Fig. 2. The shell just burst, and the head of the embryo protruding.

Fig. 3. State of the subject eight hours after it had burst the shell, at which time the pulsations of the heart are very visible.

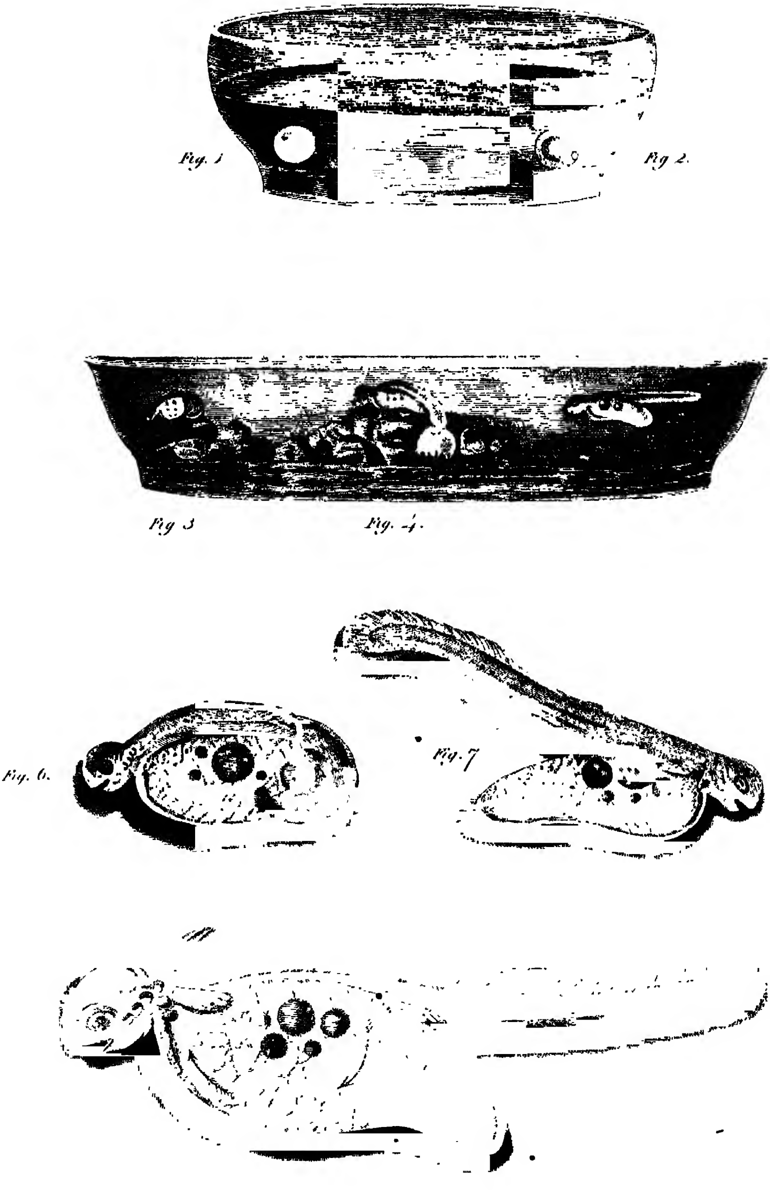
Fig. 4. The shell just thrown off, with the tail drooping: before the shell bursts, the tail envelopes the yolk or bladder, which is seen attached to the body of the fish. The shell itself is transparent, and about one-third part of it is fractured by the fish in extricating itself.

Fig. 5. The tail of the young fish has now become straight; the mouth is distinct, and the lower jaw and pectoral fins, which are quite transparent, are in motion, and keep time with the heart, which beats from 60 to 65 times in a minute: At first, the body of the fish is colourless, with slight marks of articulation of the bones, or of stripes on the skin; the bag attached to the fish is transparent, and is filled with a light amber-coloured albuminous fluid, with some drops of a clear rose-coloured oil in it.

Fig. 6. Represents fig. 3. magnified. The bag beneath the belly is extremely soft and yielding, and the shell is still seen binding the young animal.

Fig. 7. Represents fig. 5. magnified. The heart is placed before the pectoral fins, and under the throat, and is connected with a large bloodvessel that runs along the front and bottom of the bag, as is more clearly seen in fig. 8. The bag, which was at first round, becomes, in a day or two after the fish leaves the shell, more and more elongated; with a microscope, the circulation may be seen. The blood flows from under the body of the fish, through vessels which ramify upon the sides of the bag, and from these it is collected, and continued into the large vessel before mentioned, which is connected with the heart: from the heart the blood is again thrown, with regular pulsations, into the vessels of the head and throat, where it is seen to assume a darker hue, as well as to the other parts of the body: air, it is said, or some transparent fluid, is seen to circulate, in equal quan-

PLATE III.



Evolution of the Ova of the Salmo Salar or Common Salm

tity with the blood. The rays of the gills are distinctly seen, and the body of the young animal begins to assume a brownish colour.

Fig. 8. A sketch of fig. 5. magnified, to shew more distinctly the circulation of the blood.

We have no doubt of the general accuracy of these representations of the changes exhibited in the evolution of the ovum of the salmon. But the reader will bear in mind that they are not made by an anatomist, and cannot therefore be expected to present that minuteness of observation, and extent of description, into which one familiar with such subjects would have entered.

On the Temperature of the Interior of the Earth. By M. L. Cordier, Member of the Royal Academy of Sciences, and Professor of Geology in the Garden of Plants *.

THE supposition of *a central fire* is extremely ancient. It is perhaps coeval with the first dawnings of civilization, and has furnished a basis to some of the fables in which the infancy of the human race has been cradled, traces of it being found in the mythology of almost all nations. It originated from the very imperfect observation of certain natural phenomena, too obvious to have at any time escaped the notice of the vulgar. Confounded for ages amidst vague and conjectural notions, which constituted nearly all the physics of the ancients and of the middle ages, this hypothesis only began to assume some consistency, after the discovery of the laws of the planetary system. Descartes, Halley, Leibnitz, Mairan, Buffon especially, and several other philosophers of modern times, adopted it, resting chiefly upon considerations deduced from the figure of the earth, from certain astronomical phenomena, from the mobility of the subterranean principle which produces magnetic action, from the comparison of the temperatures of the surface with those observed at small depths, and from various experiments on the cooling of incandescent bodies.

The inferences derived from these sources not constituting a body of demonstration sufficiently direct to carry conviction with it, many learned men who were contemporary with those mentioned, remained undecided, while others supported the old opinion, which attributed to the earth no other heat than what it

* Read to the Academy of Sciences 4th June 1827.

may receive from the solar rays. The latter opinion at length became the prevailing one. It owed its success in a great measure to the influence of the celebrated geological system produced about the middle of the last century, of which Pallas, Saussure and Werner were the principal promoters, and which for a long time met with no opposition. This system supposes that the original fluidity of the globe took place through the medium of water, that the whole mass was consolidated, stratum after stratum, from the centre to the circumference, by aqueous crystallization; and that the volcanic phenomena are mere local effects.

The opinion on this subject has undergone a great change within these few years. This change, which has been extremely slow in its progress, so great were existing prejudices, commenced at the end of the last century. It is to be chiefly attributed to the following circumstances: Important discoveries have been made in geology; the relative position of the materials composing the oldest formations of the crust of the globe, has been found to be different from what had been formerly asserted; it has been proved that the volcanic agents reside under the primitive rocks; the true nature of lavas, and their identity in all parts of the earth, have been discovered; the analogy of a multitude of strata of all ages to lavas has been demonstrated; the facility with which all these originally fluid and incandescent matters have crystallized by mere cooling, has been proved and understood; and the theory of aqueous crystallizations has become perplexed. On the other hand, accurate and numerous facts relating to the motion of radiant heat, and of the heat which is propagated in bodies from one molecule to another, have been made known by satisfactory experiments. These facts have been connected by mathematical theories of the most general nature. Ingenious observations have placed beyond doubt the continual radiation of the superficial heat of the earth into celestial space. The ideas which have been long entertained in regard to the inconsiderable depths to which the horary, daily, monthly and annual variations of temperature reach in the soil or strata of different countries, and the level at which a fixed temperature commences, have been carefully verified. Lastly, new experiments have been undertaken regarding the temperature of deep places accessible to us, and that of the waters coming from them.

The results have been compared with one another, and with the mean temperatures of the surface, and the important conclusion has been drawn, that, proceeding from the level at which the fixed temperature commences in the soil of each country, the heat increases rapidly as the depth advances, and this in a quantity which has been valued at 1° centig. for every thirty or forty metres *.

These remarkable facts, considered partially by some, and grouped in various ways by others, have carried with them all who had a predilection for the hypothesis of central heat. The common conclusion is, that the earth possesses in its interior a temperature, incomparably more elevated than the compound temperature which is observed at the surface; and even according to some, that beyond a certain depth, there probably exist an incandescence and a fluidity, whose origin has been coeval with the commencement of things.

La Grange and Dolomieu were the first who revived the hypothesis of central heat. Hutton and his able commentator Playfair, must also be mentioned, notwithstanding the obscurity in which they involved their opinion, and the errors into which they fell when employing this principle in the support of geology. More lately, this great question has been investigated by the illustrious geometrician whose loss the sciences have to deplore, M. de La Place, and before him, by Mr. Fourier, who was naturally led into the subject by his memorable researches regarding the general theory of heat. Other authorities would not be wanting, were it possible to make mention here of the many learned men, especially in England, who, during the last twenty years, have successively adopted the same opinion.

Thus the hypothesis of subterranean heat now presents itself, supported by a mass of authorities and facts which no longer permits us to view it as a creature of the imagination. In the state in which the subject now stands, this hypothesis seems to merit the particular attention of the learned world. If the proofs adduced in its favour are insufficient, recourse must be had to new observations; if they suffice, we must hasten to adopt the principle, determine its characters, develope its consequences, and if it be possible elicit its applications.

* Metre is 3 feet and 3.371 inches English, or 39.371 inches.

If we examine the data of this great problem, it is easy to see that only one of them might lead to uncertain results. This datum, which is at the same time the most direct and the most decisive, is that which is grounded on the experiments from which it has been inferred that the temperature of the earth augments progressively from the surface toward the centre. It may be asked, if these experiments are accurate, if they have been suitably discussed, if they are sufficient, and if the inferences that have been drawn from them leave nothing to be desired?

I have thought that it would be useful to settle these doubts, and this for the interest of science in general, more than for that of an opinion which I have myself cherished for a very long time, and to which I have already paid the tribute of my researches in other points of view. Such is therefore the principal object of the memoir, which I have now the honour of communicating to the Society.

M. Cordier then proceeds to a very interesting examination of the various experiments on subterranean temperature, hitherto published, in which he discusses all that is known in regard, 1*st*, To the temperature of the water, whether running or standing, met with in mines; 2*dly*, To the temperature of the air in the shafts, galleries, and levels of mines; and, 3*dly*, To the temperature of the air in caves, as in those for instance under the Observatory at Paris. From these details he draws the following conclusions:—1. If we except a certain number of observations, as not sufficiently satisfactory, all the others announce, in a more or less positive manner, that there exists a remarkable increase of temperature, proceeding from the surface of the earth towards the interior. 2. The results obtained at the Observatory at Paris, are the only ones from which a numerical expression of the law, which this increase follows, may be deduced with certainty. This expression carries to twenty-eight metres, the depth which corresponds to the increase of 1° of subterranean heat. It results from this, that at the depth of 2,503 metres under Paris, we would reach a temperature of 212° of Fahrenheit's scale. 3. A small number only of the other results furnish numerical expressions, sufficiently near the law in question to be admitted. These expressions vary from 57 to 13 metres,

for 1° of increase; their mean announces in general a more rapid increase than that hitherto admitted. 4. Lastly, in grouping by countries all the admissible results, I am led to a new and important idea, which is, that the differences between the results collected in the same place, do not depend solely upon the imperfect nature of the experiments, but also upon a certain irregularity in the distribution of the subterranean heat in different countries.

In the second part of the memoir, M. Cordier gives a detailed account of his own experiments on subterranean temperature, made in coal-mines in France. These were conducted with great care, and are apparently the most accurate hitherto made. From these experiments, and those enumerated in the first part of the memoir, he draws the following conclusions:—

1. Our experiments fully confirm the existence of a subterranean heat, which is peculiar to the terrestrial globe, does not depend on the solar rays, and increases rapidly with the depth. 2. The increase of the subterranean heat does not follow the same law over the whole earth; it may be twice or three times as much in one country as in another. 3. These differences are not in constant relation, either with the latitudes or longitudes. 4. Lastly, The increase is certainly more rapid than has been supposed; it may go so high as a degree for every 15 or even 13 metres, in certain countries; provisorily the mean term cannot be fixed at less than 25 metres. These important conclusions, M. Cordier remarks, fix the bases, at the same time modifying them considerably, according to which the mathematical theory of the dispersion of heat, in bodies of large dimensions, may be applied to the earth. They are in harmony with the inferences derived from phenomena, of so very different a nature, which have long afforded evidence of the internal incandescence of the earth. Brought into mutual connection, these different elements give rise to new combinations, and to remarkable applications. In our opinion, there may be elicited from them numerous inductions, calculated to throw light on the most obscure, and, at the same time, the most essential parts of geology. The following are the principal of these inductions:

1. All the phenomena observed, being in accordance with the mathematical theory of heat, announce that the interior of the earth is furnished with a very elevated temperature, which is peculiar to it, and which has belonged to it since the origin of things; and, on the other hand, the volume of the earth's mass being infinitely greater than that of the mass of waters (about ten thousand times greater), it is very probable that the fluidity which the globe incontestibly possessed, before assuming its spheroidal form, was owing to heat.

2. This heat was excessive, for that which may at present exist at the centre of the earth, supposing a continued increase of 1 degree for every 25 metres of depth, would exceed 3500° of Wedgwood's pyrometer (upwards of 250,000° centigr.)

3. It must be admitted that the temperature of 100° of Wedgwood's pyrometer,—a temperature capable of melting all the lavas, and a great part of the other known rocks, exists at a depth which is very small, compared with the diameter of the earth; and, for example, from my experiments, that this depth is less than 55 leagues, of 5000 metres, at Carmeaux, 30 leagues at Littry, and 23 leagues at Decise, numbers which correspond to $\frac{1}{23}$, $\frac{1}{42}$, and $\frac{1}{55}$ of the mean radius of the earth.

4. There is, therefore, every reason to believe, that the internal mass of the globe is still possessed of its original fluidity, and that the earth is a cooled star, which has been extinguished only at its surface, as Descartes and Leibnitz thought.

5. If there be considered, on the one hand, the extent which Dolomieu's observations on the seats of volcanic foci *, and our own experiments on the composition of lavas, have given to volcanic phenomena †, and, on the other, the great fusibility of the matters which all the volcanoes of the globe at present throw up, or even of those which they ejected long ago; it must be inferred that the internal fluidity commences, at least in many points, at a depth much less than that at which the temperature of 100 degrees of Wedgwood's pyrometer.

* Dolomieu, Rapport sur ses Voyages in 1797. Journal des Mines, t. vii. p. 385.

† Recherches sur Differens Produits Volcaniques. Journal des Mines, t. xxi, p. 249. and t. xxiii. p. 55.—Memoire sur la Composition des Laves de tous les Ages. Journ. de Phys. t. lxxxiii. p. 135.

6. The crust of the earth, not including the superficial and incomplete pellicle, which is named secondary, being formed by refrigeration, it follows that consolidation has taken place from without inwards, and consequently that the layers of the original rocks nearest the surface are the oldest. In other terms, the primordial formations are so much the more recent, the deeper the level at which they occur, which is just the reverse of what has hitherto been admitted in geology.

7. M. Fourier, on considering the distribution of subterranean heat at the depths which are accessible, the temperature of the poles, and the existence of radiation toward the celestial spaces, has demonstrated that the earth continues to cool *. This cooling is insensible at the surface only, because the loss of heat there is continually compensated by the effect of a propagation, which uniformly proceeds from without inwards, a compensation which is nearly perfect, which continually approaches the state of equilibrium, and which experiment and theory perfectly explain. The loss of heat has therefore no influence but at great depths, whence there results, that the crust of the globe daily continues to increase internally by new solid layers. Thus, the formation of the primordial strata has not yet ceased; nor will it cease until after an immense period of time, that is to say, when the cooling shall have attained its limit.

8. If the crust of the earth has been formed in the manner in which we suppose it, the primordial strata with which we are acquainted ought to be disposed nearly in the order of their fusibility; I say nearly, for some influence must be attributed to the rapid action with which the cooling must have been carried on at the commencement of things, and that of chemical affinities operating upon such large masses. Now, the magnesian, calcareous and quartzose strata, are in fact the nearest to the surface.

9. According to what has been stated above, the mean thickness of the crust of the earth probably does not exceed twenty leagues of 5000 metres each. I would even say, that, according to

* General Remarks on the Temperatures of the Globe and Planetary Spaces, by M. Fourier; Annales de Chimie et de Physique, t. xxvii. 1824, p. 136.; and Resumé theorique des Proprietès de la Chaleur rayonnante, by the same, same volume, p. 275.

several geological data, not yet interpreted, and of which I shall speak on another occasion, it is probable that the thickness is still smaller. Keeping to the above result, this mean thickness would not be equivalent to the sixty-third part of the mean radius of the earth. It would only be the four hundredth part of the developed length of a meridian.

10. The thickness of the crust of the earth is probably very unequal. This great inequality appears to us to be announced by the inequality of the increase of the subterranean temperature in different countries. The different conducting powers of the strata cannot of themselves account for the phenomenon. Many geological data lead us equally to presume, that the thickness of the earth's crust is very variable.

11. The heat which the soil of each place continually disengages, being the fundamental element of the climate which is established there, and, according to our ideas, the quantities of this disengaged heat not occurring in a constant relation in different countries, it is now understood why countries, situated in the same latitude, have, other circumstances being the same, different climates, and how Mairan, Lambert, Mayer, and other philosophers, have erred in attempting to represent by formulæ the gradation, supposed by them to be regular, which the mean superficial temperature follows from the equator to the poles. There is thus also a new cause added to those which occasion the singular inflexions which the isothermal lines present.

12. Whatever be the nature of the astronomical forces or events which have formerly disturbed the stability of the continents, and occasioned the general state of dislocation and overturning which the structure of the earth's crust exhibits, it is easy to conceive that all the parts of this crust floating, if we may so express ourselves, around a perfectly fluid sphere, and being moreover infinitely subdivided, in consequence of stratification, and especially from the innumerable contractions which refrigeration has produced in each stratum, may have been dislocated and overturned in the manner in which we see them. These effects are incapable of being explained by the generally received opinion, that the superficial strata were the last consolidated, and that the globe is solid to the centre.

13. In considering the probable fluidity of the central mass.

the phenomena of earthquakes, the thinness of the consolidated crust, and especially the innumerable solutions of continuity, by which it is broken up, and which result from stratification, the contraction arising from progressive cooling, or from the overturnings that have taken place, we long ago conceived it probable that this crust possesses a certain flexibility. We developed the elements of this singular property in a memoir read to the academy in 1816, and which had the disadvantage of being presented at a period when people's minds were not sufficiently prepared for attending to researches of this nature. Now, this property is at the present moment more probable than ever. It is further conceived, from the fluidity which is to be attributed to the central matters that serve as a support to the crust, that the flexibility in question may be put into action without its being possible for us to perceive it. In fact, to produce a change of figure in the spheroid capable of raising the equator a metre, by proportionally shortening the earth's axis, it would be sufficient, in as far as concerns the plane of the equator, that each of the innumerable solutions of continuity which intersect the consolidated crust, and which I shall suppose to be five metres from each other at an average, should be subjected to a separation equal to the 1276th part of a millimetre, a quantity which is excessively small.

14. The probable flexibility of the earth's crust is supported by two principal causes, the one general and constant, the other local and transitory. The latter cause, during the last thirty years, has not spared any country. Sometimes it has shaken, almost at the same time, the twentieth part of the surface of our continents, or it has made the soil undulate in directions equal to the sixtieth or seventieth portion of a meridian; I speak of earthquakes. Since the commencement of authentic history, there have been reckoned upwards of six hundred, whose violence or extent have rendered them memorable. The second cause depends upon the circumstance, that the permanent diminution of the earth's heat no longer produces any sensible contraction in the subterranean regions in the vicinity of the surface, while it continues its effects in the deeper parts, whether for augmenting the separation of the masses which have experienced the first effects of

contraction, or for occasioning new solutions of continuity in these masses. Let it be added, that the slow formation of new solid strata in the interior, must be conformable to the general rule, in virtue of which substances in the fluid state experience a great diminution of volume in passing to the solid state.

15. The least flexible regions of the earth's crust are necessarily those near the surface, for the transverse solutions of continuity which they contain, have long since attained and lost their maximum of separation. It is evident that the central forces tend to bring nearer to each other the elementary masses of the superficial regions, in proportion as the cooling contracts more and more the volume of all the internal parts of the globe. This approximation would act in a uniform manner, if the strata of the consolidated crust were concentric, and if all the transverse solutions of continuity were directed in planes perpendicular to the surface; but this is not the case. The shattered state of the primordial crust is such, that, considering it in the great scale, I can only define it as a heap of fragments pressed against each other, and of which the strata are always very much inclined or vertical. Since the establishment of this state, the obliquity of an innumerable quantity of solutions of continuity, of which some have an immense extent, forms an obstacle to the establishment in all points of an approximation of the elementary masses that might be uniform and proportionate to the central contractions. Changes of level of no great extent, but which may have affected great continental surfaces, have been substituted for this approximation. Many geological facts agree with this hypothesis. It is to be presumed that this effect still subsists at the present day, although in an imperceptible manner. If the secular raising of the basin of the Baltic is constant, it may be accounted for in this manner. The above hypothesis will also explain the change in the level of the Mediterranean, which we observed with Dolomieu on the shores of Egypt *. There is reason to think, according to our opinion, that at present this part of the African continent is undergoing a progressive lowering, which may amount to two or three centimetres in a century.

16. M. de Laplace, estimating the astronomical observations

* See my description of the ruins of San (the Tanis of the ancients), in the great work on Egypt.

DUNN'S IMPROVED AIR PUMP.

Fig 2.

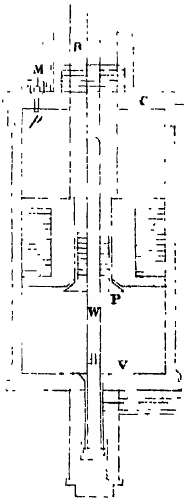


Fig. 1.

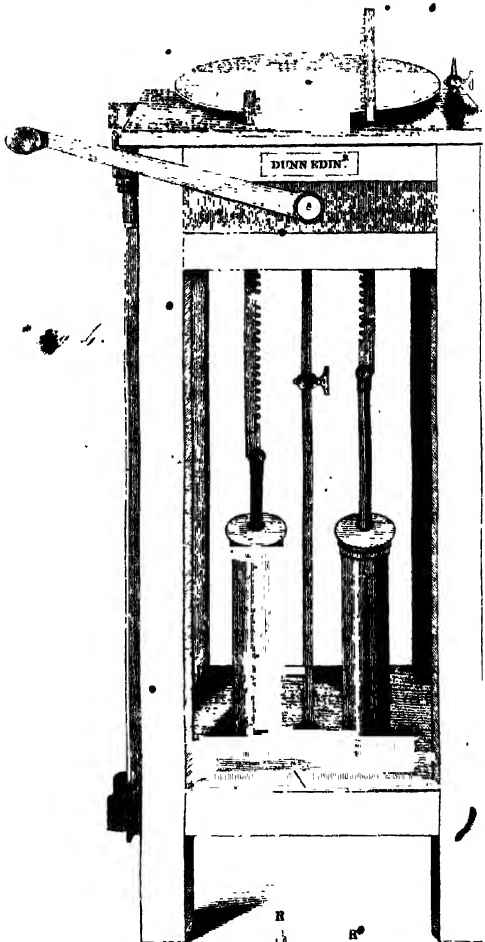
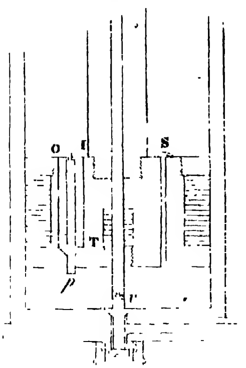
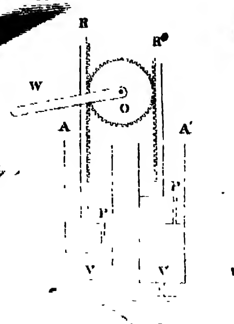


Fig 3.





Fig

made in the time of Hipparchus to be sufficiently accurate to afford evidence that the duration of the day has not diminished $\frac{1}{300}$ of a centesimal second for twenty centuries, thought that the contraction which is actually produced by the secular cooling of the globe, is not sufficiently great to increase the velocity of rotation in a sensible degree. This opinion gives us a useful limit of the actual effect of the general refrigeration.

17. But if the effects of contraction since the commencement of the cooling are considered, one cannot help admitting that it has exercised a certain influence in the above point of view. On the one hand, the duration of the day has successively diminished a small quantity; and, on the other, the figure of the earth must have undergone a slight alteration, in consequence of the acceleration of the velocity of rotation, provided the flexibility of the consolidated crust has been sufficient to permit the change of figure, which we admit as being the case. Thus at present the day is a little shorter, and the spheroid a little flatter toward the poles, than at the commencement of things. If these data are correct, it is evident that the two effects continue. All that is to be done is to find a better means than that mentioned above for appreciating the feeble intensity; which is not impossible, as we shall presently see.

18. Another consequence, not less probable, and not less curious, to which we are led by the hypothesis of central incandescence and fluidity, is the following. However little the crust of the earth may be influenced by the flexibility which, according to our ideas, must be attributed to it, it follows that the phenomenon of the tides is exercised, without its having been hitherto suspected, upon the terrestrial mass itself. This effect, which, besides, must be excessively feeble, will not excite astonishment, when we reflect that it certainly existed at the commencement of things, that is to say, when the surface of the globe possessed the perfect fluidity which is admitted in all the theories. It is easy to demonstrate that the greatest of these ancient land-tides could not have been less than from four to five metres.

19. As the secular refrigeration of the earth is continually increasing the thickness of its crust, it may be asked if the incandescent matter which is subjected to this action, passes entire-

ly into the solid state; or if it is decomposed, so as to furnish solid parts and gaseous parts. There is nothing improbable in the latter idea; in fact, the consolidation of lavas daily presents a very striking example of the production of gas by refrigeration. If we admit this supposition, we can account for the origin of the first matter of earthquakes in a very natural manner. An excessive temperature keeps this first matter in the gaseous state, notwithstanding the enormous pressure which it experiences at these great depths. The capricious nature of the phenomena of earthquakes would also be accounted for by the extreme inequality of the internal surface of the crust of the earth.

20. The preceding data lead to an entirely new explanation of volcanic phenomena; an explanation which will perhaps appear more satisfactory, at least to the very small number of persons who have a just and complete idea of the elements of the question, than any that has hitherto been proposed. These phenomena appear to us a simple and natural result of the internal refrigeration of the globe, a purely thermometrical effect. The internal fluid mass is submitted to an increasing pressure, which is occasioned by two forces whose power is immense, although their effects may be slow and not very perceptible. On the one hand, the solid crust contracts more and more in proportion as its temperature diminishes, and this contraction is necessarily greater than that which the central mass experiences in the same time; on the other hand, this same envelope, in consequence of the insensible acceleration of the rotatory motion, loses its internal capacity in proportion as it recedes more from the spherical form. The internal fluid matters are forced outwards, under the form of lavas, by those habitual vents which are named volcanoes, and with the circumstances which the previous accumulation of gaseous matters, which are naturally produced in the interior, give to eruptions. This hypothesis needs not excite astonishment, for I can demonstrate its probability by a very simple calculation.

In 1803 I cubed in Teneriffe, as nearly as it was possible, the matters ejected by the eruptions of 1705 and 1798. I performed the same operation with regard to the products of two eruptions still more perfectly isolated, which exist in the extinct

volcanoes of the interior of France, viz. (in 1806) those of the volcano of Murol in Auvergne, and (in 1809) those of the volcano of Cherchemus, near Issarles at Mezin. I found the volume of the matters of each eruption much inferior to that of a cubic kilometre *. From these data, and others of a similar kind, which I have collected in various parts, I consider myself warranted to assume the volume of a cubic kilometre, as the extreme term of the product of eruptions considered in a general sense. Now, such a mass is almost nothing compared with the bulk of the globe. Spread over its surface, it would form a layer not more than one five-hundredth part of a millimetre in thickness †. In exact terms, if we suppose the crust of the earth to have a mean thickness of twenty leagues of 5000 metres, a contraction capable of shortening the mean radius of the central mass $\frac{1}{394}$th of a millimetre, would be sufficient to produce the matter of an eruption.

Proceeding on these data, if we suppose that contraction alone produces the phenomenon, and that over the whole earth there take place five eruptions annually, we find that the difference between the contraction of the consolidated crust and that of the internal mass, only shortens the radius of that mass one millimetre in a century. If there be only two eruptions yearly, it takes two centuries and a-half to produce the same shortening. We see, that, in all cases, an excessively small action is sufficient to produce the phenomena.

It will be remarked, that this action, if it be real, is necessarily in connection with the total contraction which the globe experiences from the effect of secular cooling. It furnishes a basis for calculating the very slight influence which this total contraction exercises in accelerating the velocity of rotation.

Nothing less than the enormous power, which I have pointed out, could suffice to raise the lavas. In the particular case in which they would come exactly from a depth of twenty leagues it is easy to prove, from their mean specific gravity, that they would be pressed by a force equivalent to that of about 28,000 atmospheres. It is, besides, well known, that they flow almost always after the eruption of the gaseous matters, which may very easily be conceived, according to my theory.

* The Kilometre is 39371,00000 cubic English inches.

† The Millimetre is .03937 English cubic inches.

This is not the place for developing the purely thermometrical hypothesis which I propose for explaining volcanic phenomena, and shewing with what success it may be applied to all the details of these phenomena. I shall content myself with remarking, that it accounts for the identity of circumstances by which the manifestation of volcanic action, in all parts of the world, is characterised, for the prodigious reduction which the number of volcanoes has undergone since the commencement of things, for the diminution that has been effected in the quantity of matters ejected at each eruption, for the nearly similar composition of the products of each geological epoch, and for the small differences that exist between the lavas which belong to different epochs. Lastly, in this hypothesis, the most usual directions of earthquakes announce the thinnest zones of the earth's crust; and the volcanic centres, as well ancient as modern, constitute, at the same time, the points at which this crust has the least thickness, and presents the smallest resistance.

In the above I have not calculated upon the gaseous matters which each eruption produces, because, supposing them reduced to the state of liquidity which they originally had in the mixture from which they have been disengaged, their volume would be very inconsiderable, and because the mean of one cubic kilometre, which I have adopted, is much above the real mean.

21. The greater part of the substances contained in mineral and thermal waters being analogous to those which are exhaled by craters during and after eruptions, and by currents of lava when they crystallize, as well as by solfaterras, it must be supposed that they come from a common reservoir. Their emission occasions continual losses to the internal gaseous *charge.* These losses, which, however, are incessantly repaired by new subterraneous products, take place in virtue of an expansive power, which is immense, and through a succession of extremely narrow fissures. The water is furnished by the superficial causes which feed common springs. The alteration of certain parts of the canals, especially near the surface, may sometimes occasion the substitution of certain principles by others. In this system of explanation, it is easy to conceive the permanence of the springs, their nearly invariable temperature, and the singular nature of their principles. Several phenomena appear to me to

prove that they were much more numerous at periods antecedent to the present geological epoch. This circumstance is explained by the greater thinness of the earth's crust at that time, and the more rapid progress of refrigeration.

22. If we judge by the appearance of lava, the fluidity of the incandescent matter which constitutes the interior of the earth is very great, and its density in the regions, situated at a distance from the centre, (for example, at a distance equal to $\frac{4}{5}\frac{0}{0}$th of the radius,) is much inferior to the mean density of the whole globe. These two data are not in opposition to the influence which must be accorded to the enormous and increasing pressure which is due to the action of the central forces. It is to be observed, in the first place, that fluids can be very little compressed, that their compressibility in this case must have a limit, and that its effects may be balanced by excessive heat. Moreover, the present lavas have, after their consolidation, a mean specific weight, greater than that of the primordial rocks taken together; from which it may be concluded, independently of every other consideration, that the density of the central matters depends much more upon their nature than upon pressure; they have been originally placed in the order of their specific gravities. The existence of gold and platina proves that substances having, from their nature, an extreme density, may occur at the centre of the earth.

23. The preceding statement shews, that there is some probability in the hypothesis of Halley, who attributed the magnetic actions to the existence of a mass composed in a great measure of metallic iron, of irregular form, and possessing a particular revolving motion, situated at the centre of the earth. Two kinds of phenomena, of which Halley had no knowledge, add to this probability. On the one hand, the rotation of the ring of Saturn round that planet may be brought forward as furnishing a sort of analogy; and, on the other, the nature of the stones that have fallen from the sky, and the existence of meteoric iron, prove that iron in the metallic state, and alloyed with nickel, may enter abundantly into the composition of the planetary masses.

24. If Halley's hypothesis be admissible, it furnishes the limit of the internal temperature of the earth. This limit is

that of the resistance which forged iron, subjected to an enormous pressure, is capable of opposing to fusion. We might be inclined to reduce the temperature, on considering that Newton's experiments, confirmed by those of Mr Barlow, have proved that iron, raised to a white heat, loses its magnetic virtue. But, on the other hand, it must not be lost sight of, that an excessive pressure of the metal should probably protract in a great degree the term at which the magnetic virtue is thus destroyed.

25. Lastly, According to the same hypothesis, there would be reason for making inquiries respecting various extremely slight, secular, and not hitherto perceived, effects, which the different positions, and the irregular form of an internal solid mass, possessed of a peculiar motion, and composed in part of metallic iron, might occasion. Thus, for example, we might be led to doubt the perfect and absolute invariability which has hitherto been attributed to the direction of the plummet in each place; and this doubt would apply to countries distant from the zones without declination, and from the magnetic equator.

Such are the principal inferences at which we arrive, on introducing the hypothesis of central heat and fluidity, amidst the most important questions of geology. It would be easy to extend these inferences, and, for example, to explain, in an equally satisfactory manner, the formation of the unstratified primordial rocks, that of the transition rocks, of veins, and of the gypseous, sulphureous, saline, calcareous and magnesian strata of the secondary series. The fecundity of applications is remarkable, and adds to the probability of the principle. The case is different with the Neptunian system, which so long prevailed, and which represents the globe as a cold inert mass, solid to the centre, and formed from within outwards by aqueous depositions. This system has proved a sterile one, and none of its applications are now able to stand a serious examination. It reduces itself to narrow limits, to the explanations of those superficial strata, formed of consolidated sedimentary matters, of agglomerated debris and organic remains, which constitute almost the whole of the excessively thin envelope, named secondary. Had not the authority of the naturalists who brought this system into credit, given a bias in its favour, it is evident that, at its commencement, it would have been made to undergo a very simple trial, from

which it could not have escaped, namely, the comparison of the masses of water and of earthy and metallic matters, which enter into the composition of the globe. It is easy to shew that the weight of the mass of water does not exceed the fifty-thousandth part of the weight of the whole globe. Now, with whatever solvent this mass has been quickened, it is inadmissible that one kilogramme of water could ever have dissolved 50,000 kilogrammes of earthy and metallic matters.

We may be permitted again to remark, that it is not the spirit of system by which we are now led to the idea of central fire; it is in spite of such a spirit, and in opposition to many prejudices. This return to a former opinion is occasioned by an accurate and profound examination of phenomena of very different orders. It cannot be believed that by mere chance natural philosophy, astronomy, and geology have arrived at the same point, after following such different paths. We may therefore affirm, without fear of being considered hasty, that the hypothesis which is equally a desideratum in all these sciences, seems already to present the characters of a real and fundamental principle; and every thing seems to predict, that it will have as powerful an influence upon the progress of the theory of the earth, as that which the great principle of gravitation has exercised upon the theory of the motion of the celestial bodies.

From the present state of this discussion, it would seem that the Academy ought no longer to remain neutral on so important a question. Perhaps it may now be time to carry into effect a measure proposed at the sitting of the 28th November 1825, on the recommendation of M. de La Place *. Perhaps, also, it would be proper to direct the attention of scientific men, in general, to the subject, by offering prizes for the successful discussion of some of the elements of this great question.

The determination of the figure of the earth has occupied the Academy for upwards of a century; the investigation of the prin-

* The measure in question was the naming a commission of six members (MM. de la Place, Arago, Poisson, Thenard, Gay Lussac, and Dulong), who were directed to make out a programme of experiments to be performed, that the Academy might be enabled to determine, by correct experiments, *1st*, The state of the earth's magnetism; *2dly*, The pressure and composition of the atmosphere; *3dly*, The heat of the globe at different depths.

ciple which presides over the structure of the globe, and which regulates all the phenomena depending upon it, is not less worthy of its efforts, or beneath the talents and resources which it has at its command. The object is certainly one of the most elevated to which the human mind can aspire: its attainment would, moreover, be of the highest importance to the whole philosophy of science. If it is averred that the earth is not an inert mass, as it has been so long supposed; if the appearance of inertia is only owing to the slowness of the phenemena, and their feeble intensity: if all is in motion and in labour in the interior, as all is in motion and in labour on the outside of the globe, we arrive at a result of the highest importance, since it seems applicable to all the celestial bodies; and there is thus obtained a most powerful proof of the existence of the great principle of *universal instability*, which was long ago announced or foreseen by Newton and other philosphers; a principle superior to the great rules which we are accustomed to regard as exclusively constituting the laws of nature, by the aid of which we see beyond the longest and apparently most perfect periodicities of our solar system, which appears to govern the universe even in its minutest parts, which continually modifies all things, alters and displaces them insensibly and irrevocably, and leads them through the immensity of ages, to new ends which human intellect cannot assuredly penetrate, but of which it may at least boast of having foreseen the necessity.

Memorandum from the Right Honourable the LORD PRESIDENT, *containing some facts relating to the Natural History of the Swallow and the Partridge.*

To Professor Jameson.

ABOUT eighteen or twenty years ago, The Lord President, then Lord Justice-Clerk, left his house at Granton, on the 17th of April, to go on the West Circuit.

There had been a fall of snow the night before, the 16th, and it lay on the ground two or three inches deep. He breakfasted with Solicitor Blair at Aventon, near Linlithgow, where the snow was still deeper, and the frost keen. He stop-

ped to bait his horses at the village of Larbert, the snow still lying there. While his horses were feeding, he walked along the lane towards Carron, where the works were in full activity, six or seven furnaces being then in constant employment. As he approached the works, the effects of the heated air from the furnaces became very apparent; and when he came to the great Mill Pond, he found the snow entirely gone; the air swarming with gnats and other insects, and numbers of swallows skimming over the mill-pond. On remarking this to one of the workmen whom he met, the man answered, "Oh aye, sir, we seldom miss the swallows here."

For some years after he settled at Granton, swallows constantly built in the corners of his windows, which, of course, they dirtied and obscured. This was a great obstruction to the view of the Forth. At last, it occurred that they might be prevented from building, by rubbing the corners of the windows with oil or soft soap. This was accordingly done early in the next season. The swallows began to build as usual; but as fast as they attempted to attach their materials to the stone, they slipped off. They renewed their attempts for some days; and then gave the matter up; and, what is very remarkable, although the oiling has never been renewed, and the effects of it must have long ago ceased, not a single swallow has ever attempted, since that time, to build on the windows here, not even in those which had not been oiled. Nay, they do not even build in the mock windows; though one constantly builds in the coal cellar, to which it can only get by diving under an open doorway, and where the servants are breaking coals every hour of the day.

At Tyninghame, the seat of the Earl of Haddington, the kitchen is in a building separated from the main house by an open court, but connected with it by a covered passage, supported by posts, and open to the south. In the corner of the passage, close to the kitchen door, a bracket is placed for holding a lamp, which is taken down to be trimmed every day, and lighted every evening. On that bracket a swallow, and it is believed the same swallow, built her nest for three or four years, quite regardless of the removal or light of the lamp, and the constant passing and repassing of the servants.

On the opposite side of the same open court, the great house-bell is hung, under a wooden cover, fastened to the north wall of the house. It is a large bell, and is rung several times a-day, to call the servants to their meals. Under the wooden cover of this bell, the same swallow, it is believed, which had formerly built on the bracket for the lamp, built a nest for several years, and never was in the least disturbed by the ringing of the bell, or the rattling of the rope.

I may take this opportunity of mentioning a very curious fact relating to the *partridge*, which also occurred at Tyninghame. Lord Haddington has a breed of wild turkeys, which never enter the poultry house or yard, but roost in the trees, and live chiefly on beech-mast, and any thing else they can pick up, though they are tame enough to come about the house to be fed, in the time of frost and snow. About eight or ten years ago, a cock partridge, full grown, suddenly joined himself to the flock of these turkeys, and remained constantly with them during the whole summer, autumn, and winter; at night he slept under the trees in which they roosted; in the day he fed with them, and was not in the least frightened or disturbed by people walking among them. He took great liberties with the old turkey cock; when he saw him going to pick up a worm or any seed, he used to run under him, between his legs, and snatch it out of his mouth, and the old gentleman never resented such indignities. Early in spring he left them, as it was supposed, to find himself a mate, at the pairing season. But, in the beginning of autumn, he rejoined his old friends, and continued with them as formerly, until the next pairing time, when he again disappeared, and returned no more, so that he was probably killed.

Essay on the Domestication of Mammiferous Animals, with some introductory considerations on the various states in which we may study their actions. By M. Frederick Cuvier. (Continued from p. 60.)

LET us inquire, therefore, now that we know the animals which are associated with us, what is the disposition common to

some and foreign to others, which might be regarded as essential to domesticity; for, without a particular disposition which would second our efforts, and prevent our empire over animals from being merely accidental and transitory, it is impossible to conceive how we should have succeeded in domesticating animals, had all of them resembled the wolf, the fox, and the hyena, which constantly seek seclusion, and even flee the presence of other individuals of their own species. Perhaps, by means of perseverance and labour, we might be able to form among these animals races familiarized in a certain degree to man, so as to become habituated to his neighbourhood, and even to prefer it, from the advantages which they would derive from it, as has been done in the case of the cat, which lives among us; but between this and domestication there is a wide difference. Besides, to attain an object it is necessary to know it, and how could the first men, who associated themselves with animals, have known this object? And had they conceived it hypothetically, would not their patience have been exhausted in vain efforts, from the innumerable attempts they would have had to make, and the great number of generations on which they would have to act, in order, after all, to arrive only at imperfect results. Thus, the more we examine the question, the more evident does it become, that a high degree of intellect, great mildness of character, the fear of chastisement or the acknowledgment of benefits, are insufficient of themselves to render an animal susceptible of domestication; and that a particular disposition is indispensable to make animals submit and attach themselves to the human species, and to render its protection necessary to them.

This disposition can only be the social instinct carried to a very high degree, and accompanied with qualities calculated to aid its influence and developement; for all the social animals are not susceptible of domestication. But all our domestic animals which are known in their natural state, whose species still remain in part wild, or of which some of the races have accidentally returned to their original condition, form more or less numerous herds; while no solitary species, however easy it may be to tame it, has afforded domestic races. In fact, it is sufficient to examine this disposition, to see that domesticity is but a

mere modification of it. To establish this truth, I shall not repeat what I have already stated respecting sociability in the memoir which I published on that subject; I shall merely consider the domestic animals, with regard to man, as compared with what the social animals are with regard to one another.

When, by our benefits, we have attached to us individuals of a social species, we have developed to our own advantage, we have directed toward ourselves, the propensity which impelled them to draw near to their fellows. The habit of living near us has become in them a want so much the more powerful, that it is founded in nature; and the sheep which we have reared is led to follow us as it would be led to follow the flock among which it was brought forth; but our superior intellect soon destroys all equality between animals and us; and it is our will which governs theirs, as the stallion, which, from its superiority, has become the chief of the herd which it leads, draws after it all the individuals of which this herd is composed. There is no resistance, so long as each individual can act conformably to the wants by which it is excited; it commences whenever this situation is changed. It is for this reason that the obedience of animals to us is not more absolute than to their natural chiefs; and if our authority is greater than theirs, it is because our means of enticement are also greater, and because we have been able to restrain, in a great degree, the inclinations which, in the natural state, would have excited the will of the animals which we have associated with us. The individuals which have passed from hand to hand, which have had several masters, and in which, from this circumstance, most of the natural dispositions are weakened, if not effaced, appear to shew the same docility toward every person; they are subjected to the whole human species. This state of things cannot exist with regard to animals that are not domesticated; but the analogy recurs, when we consider the individuals, whether isolated or in herds, which have never had but one master; it is he alone whom they acknowledge as their chief, he only whom they obey; every other person would be unknown, and would even be treated as an enemy by the species which do not belong to races over which domestication has exerted its whole influence, that is to say, as an individual would be treated when he presented him-

self for the first time in a wild herd. The elephant only allows himself to be led by the cornac whom he has adopted; the dog itself, reared in solitude with its master, manifests a hostile disposition toward all others; and every body knows how dangerous it is to be in the midst of a herd of cows, in pasturages that are little frequented, when they have not at their head the keeper who takes care of them.

Every thing, therefore, tends to convince us, that formerly men were only, with regard to the domestic animals, what those, who are particularly charged with the care of them still are, namely, members of the society which these animals form among themselves; and that they are only distinguished in the general mass by the authority which they have been enabled to assume from their superiority of intellect.

Thus, every social animal, which recognises man as a member and as the chief of its herd, is a domestic animal. It might even be said, that, from the moment when such an animal admits man as a member of its society, it is domesticated; as man could not enter into such a society without becoming the chief of it.

Should we now apply these principles to the wild animals, which are of a nature that renders them capable of subjection, we should see that there are still several which might become domesticated, were it necessary to increase the number of those which we already possess.

Although the apes and monkeys have the qualities of most importance for domestic animals, the social instinct and intellect, yet the violence and irritability of their character render them absolutely incapable of all subjection, and consequently excludes them from the number of animals which we are capable of associating with us. The American quadrumana, the makis, and the insectivora, are equally excluded; for, were they social and susceptible of domestication, their weakness would render them useless.

The seals, perhaps, more than any other carnivorous animals, together with the various species of the dog tribe, would be the best adapted to attach themselves to us, and serve us; and it is astonishing that the fishing tribes of our species have not trained them for fishing, as the hunting tribes have trained the dog to the chase.

I shall not detain the reader with the didelphides, the glires and the edentata; the weakness of their body, and their limited intellect, prevent them from being employed by us for any useful purpose. But almost all the pachydermata, which are not yet domesticated, might be so; and it is especially to be regretted that the tapir is still in a wild state. Much superior to the boar in size and docility, it would afford domestic races not less valuable than those of the hog, and whose qualities would certainly be different, for the nature of the tapir, notwithstanding some points of resemblance, is very different from that of the boar. Yet the tapir, which has but feeble means of defence, is destroyed in America, where it is much sought after on account of the excellence of its flesh. Now, however little addition may continue to be made to the population of South America, the species peculiar to that country will gradually disappear from the face of the earth

All the species of solipeda are as capable of being domesticated as the horse or the ass; and the education of the zebra, the quagga, the dauw *, and the hemionus, would prove useful to society, and lucrative to those who might undertake it.

Almost all the ruminantia live in herds, and most of the species of this numerous family are of a nature that qualifies them for domestication. There is one, in particular, and perhaps even two, that are already half domesticated, and which it is matter of regret that we do not see among the number of our domestic animals, for they would have two very valuable qualities,—they would answer as beasts of burden, and would furnish fleeces of excellent quality. The animals of which I speak are the Alpaca and the vicugna. They are double the size of our largest breeds of sheep; the qualities of their fur are very different from those of wool, properly so called, and might be manufactured into cloths, which would partake of these qualities, and thus give rise to a new branch of industry †.

* The *Equus montanus* of Burchell.

† The difference of climate has been stated as an insurmountable obstacle to the naturalization of the animals of warm countries in our northern regions. This error would have been avoided, had the resources of nature and the extent of our means of acting upon animals been better known. By a similar error, the same difficulty has been opposed to the introduction of the

I shall now bring my observations upon domestication to a conclusion. My object has been to shew its true character, as well as the relations of the domestic animals to man. It rests upon the propensity which animals have to live together in herds, and to attach themselves to one another. We obtain it only by enticement, and principally by augmenting their wants and satisfying them. But we could only produce domestic individuals and not races, without the concurrence of one of the most general laws of life, the transmission of the organic or intellectual modifications by generation. Here one of the most astonishing phenomena of nature manifests itself to us, the transformation of a fortuitous modification into a durable form, of a fugitive want into a fundamental propensity, of an accidental habit into an instinct. This subject is assuredly worthy of exciting the attention of the most accurate observers, and of occupying the meditations of the most profound thinkers.

This essay is undoubtedly far from containing all the developements of which domestication is susceptible; for, to treat of this subject fully, nothing less would be requisite than to convert into a science one of the most important branches of human industry, the treatment of animals, or, in other words, to submit to laws founded in Nature—the blind practices and empirical rules according to which people are generally directed at the present day. But my researches will not be without use if they shew the principles according to which we may conduct ourselves, in order to act effectually upon the natural disposition of animals, the methods which should be followed for improving them, and all that might be expected in this department from an enlightened and persevering direction of the means placed within our power.—*Memoires du Museum d'Histoire Naturelle.*

alpaca and vicugna into Europe, animals which live only in very temperate regions; but it would not even be applicable to the tapir, although a native of the warmest countries.

On the History and Constitution of Benefit or Friendly Societies. By Mr W. Fraser, Edinburgh. Continued from p. 91.

It was formerly remarked, that, in order to place Friendly Societies upon equitable and permanent principles, it is indispensably requisite that all their calculations for contributions and benefits should be founded upon such rates of sickness and mortality as are most likely to occur among their members, and also upon the rate of interest which will most probably be obtained for their money. The last of these subjects only now remains to be noticed, the two former having been already fully discussed.

Rate of Interest.

By the statute 59th Geo. III. c. 128, Friendly Societies in England, whose rates of contribution have been certified by two actuaries to be adequate to the allowances, and whose rules have been approved of by the Quarter Sessions of the Peace, are allowed to pay in their money to the Bank of England, in sums not under L. 50 at a time, to the account of the Commissioners for the reduction of the National Debt, and to draw interest on all such sums at the rate of threepence per cent. per day, or somewhat more than 4½ per cent. per annum. They are likewise authorised to lodge any sum or sums below L. 50 in the Savings Banks, and to receive interest on these at the rate of 4 per cent. per annum. By these privileges, societies in England can always calculate upon receiving 4 per cent. interest at least, besides the advantage of having the whole or any part of their capital always at command, without the risk of loss.

The above statute, however, only applies to England; and, consequently, the Friendly Societies of Scotland are obliged to have recourse to other modes of investment. This being the case, the rate of interest to be assumed becomes with them a question of some difficulty; and the only guide which can with propriety be taken, seems to be the rate of interest hitherto derived from the Public Funds; for, although societies in Scotland have usually disposed of such portions of their capital as were not immediately required, in house property and other similar purchases, which produced a higher nominal rate of interest than could have been obtained for money on loan; yet it has generally been found, after deducting occasional losses, and the heavy expences necessarily attending such investments, that the ultimate produce has not been so much as if the capital had been lent on heritable securities at a constant rate of 4½ or 5 per cent. interest.

With the view of obtaining some approximation to the average rate of interest in this country, Mr Babbage examined a period of ninety-two years of

peace and war, from 1731 to 1822, and, by extracting from the tables collected and published by M. Caesar Moreau, the highest and lowest price of the Three Per-cents each year, he found that the average annual price was 73.1 during 48 years of war, 86.14 during 44 years of peace, and 79.33 during 92 years of war and peace. According to these rates, he states the averages to be 4.1 per cent. during war, 3.48 per cent. during peace, and 3.78 per cent. during war and peace; or a little more than an average rate of 3¾ per cent. during the whole period of 92 years *. But Mr Finlaison, actuary to the National Debt Office, states, from the opportunities he has had, in his official situation, of observing the prices at which the Commissioners have purchased stock, that, upon a medium of the last forty years, the rate of interest realised from the investment of money in the Three Per-cents, the highest of all funds, has been precisely the same as if it had been invested at one uniform and constant rate of 4½ per centum; and that this observation holds equally true for the period of the last twenty years. Mr Finlaison therefore infers, that, for a long time to come, the interest of money in this country may be calculated at 4 per cent †.

From these circumstances, then, we would venture to conclude that Friendly Societies in Scotland may safely calculate upon 4 per cent. interest; for, although some small sums must always be reserved to meet current demands, and be consequently unproductive of interest; yet, on the other hand, it is to be remembered that they have no bad debts, that a very high rate of interest in the shape of fines is charged for all sums in arrear, and that it is generally practicable to make some better investments than even in the Three Per-cents.

Contributions and Benefits.

At the commencement of every Friendly Society, there must be necessarily fixed some standard rates of contributions and benefits, a minimum and maximum age at which entrants shall be admitted, and the periods when the benefits shall commence, diminish, and cease. It does not follow, however, that one uniform rate of payments and allowances must be adopted for all the members by each society, as has hitherto been the almost universal practice; but only that some certain rate of contribution and allowance be properly adapted to each other, so that other higher or lower rates may be therefrom deduced. In every rightly conducted society, therefore, a member should be allowed to take one or more of the benefits, and such allowance from each as he may find suited to his own circumstances.

The benefits of Friendly Societies, it was formerly mentioned, usually consist of weekly allowances during sickness and infirmity, of sums payable at death, and, in some cases, of annuities to widows. The amount of allowance in sickness is generally regulated by its intensity or duration,—bedfast, walking and permanent sickness forming one class of payments, while sickness of the first, second, third, and fourth quarters, or periods of three months, and superannuation (*i. e.* sickness or infirmity of unlimited continuance), form another,—the

* A Comparative View of the various Institutions for the Assurance of Lives, by C. Babbage, Esq. London, 1826.

† Report of the Select Committee of the House of Commons respecting Friendly Societies in 1825, p. 48.

rate of allowance in both diminishing progressively at each step of the scale. It will therefore be obvious, that the expenditure for sickness must depend upon the quantum which may occur, and the sum stipulated to be paid weekly during each of these periods; and hence it is necessary to take an average of the whole, in order to ascertain the requisite contributions for societies adopting either of these scales of payments.

When Dr Price made his calculations for Friendly Societies, he divided the allowance during sickness into "Bedlying Pay" and "Walking Pay;" but it does not appear what proportion he conceived they would bear to each other. Assuming, however, as before stated, that, in societies consisting of persons under 32 years of age, a forty-eighth part of them would be always in a state of incapacity for labour by illness and accidents; that from the age of 32 to 42 this proportion would increase one-fourth; from 43 to 51 one-half; from 52 to 58 three-fourths; and from 59 to 64 double—he calculated the following Table of rates of Contributions and Allowances.

"*TABLE shewing the Weekly Allowances, during Incapacities of Labour, produced by Sickness or Accidents, and the corresponding Weekly Contributions necessary to entitle Persons to those Allowances.*

	Class.	Ages of Contributors at Admission. Under 32.	From 32 to 42.	From 43 to 51.	From 52 to 58.	From 59 to 64.		Class.	Bedlying Pay.		Walking Pay.
		d.	*d.*	*d.*	*d.*	*s.*	*d.*		£	*s.*	*s.*
Weekly Contributions.	I.	1	1¼	1½	1¾	0	2	Weekly Allowances. I.	0	4	2
	II.	1½	1⅞	2¼	2⅝	0	3	II.	0	6	3
	III.	2	2½	3	3½	0	4	III.	0	8	4
	IV.	2½	3⅛	3¾	4⅜	0	5	IV.	0	10	5
	V.	3	3¾	4½	5¼	0	6	V.	0	12	6
	VI.	3½	4⅜	5¼	6⅓	0	7	VI.	0	14	7
	VII.	4	5	6	7	0	8	VII.	0	16	8
	VIII.	4½	5⅝	6¾	7⅛	0	9	VIII.	0	18	9
	IX.	5	6¼	7½	8¾	0	10	IX.	1	0	10
	X.	5½	6⅞	8¼	9⅝	0	11	X.	1	2	11
	XI.	6	7½	9	10½	1	0	XI.	1	4	12

"*N. B. The ages in this and the following tables are the ages at admission, and the contributions at admission are reckoned to continue invariable till they cease at sixty-five* *."

It is here to be remarked, that the contributions and benefits for sickness are both intended to stop at the age of 65; and that the "following tables" alluded to in the note, refer to annuities or superannuation allowances, which were to supersede those for sickness, at the age of 65. The proportions which the allowances bore to each other, were, 12s. per week bed-lying pay (*i. e.* when disabled); 6s. per week walking pay (or when not totally disabled); 6s. per week after 65, whether ill or well; and this latter sum doubled at 70,—a member being considered to be then totally unfit for labour. The contributions

* Price on Reversionary Payments, 7th edit. vol. ii. p. 477.

for annuities were combined with those for sick allowances, and calculated to commence at 21 years of age; and the contributions for both sickness and annuities, were entirely to cease at 65, when the superannuation allowance became payable. By this plan, however, of combining the payments for sickness and annuities, many societies, and even some actuaries, were led into error, it having been supposed that the contributions in the above table were suitable for sickness during the whole period of life, instead of only to the age of 65 *. But the general failure of Friendly Societies cannot be wholly attributed to this mistake, by far the greater number of them having adopted no calculation whatever.

The Committee of the Highland Society of Scotland having taken as a standard the average of the whole sickness in each decade reported to them by Friendly Societies, resolved, for sufficient reasons stated by Mr Oliphant in his Report, 1*st*, To commence their computations at the 21st year of age; 2*d*, To present a view, in the simplest form, of the course of a society's affairs, supposing that 1005 members would enter in the 21st year of their age, that all would continue till death, and that no new members would be admitted; 3*d*, To assume that the various contributions should be payable whether in sickness or in health; 4*th*, To institute computations for annuities or superannuation allowances to such members as should survive their 70th year of age; 5*th*, To found the calculations upon a medium rate of mortality derived from the Northampton, Carlisle, and Swedish Tables; and, 6*th*, To consider 4 per cent. as the rate of interest which would be received for the society's stock.

The society was supposed to embrace *four* schemes. 1*st*, For Weekly sick allowances, both the contributions and benefits commencing at the 21st, and terminating at the 70th year of age; 2*d*, Life annuities, the contributions commencing at the 21st, and terminating at the 70th year of age; but the annuities only commencing at the 70th year, and then continuing during life; 3*d*, A sum payable at death, the contributions for which, commencing at the 21st, and terminating at the 70th year of age, should a member live so long; and, 4*th*, Annuities to widows, the contributions commencing at the 21st, and terminating at the 70th year of age. All, or only some of these schemes, however, and one or more contributions for the whole, could be adopted or consolidated, as a society might judge proper. Both contributions and allowances were considered to be payable in the middle of the year, as the payments to societies are usually made monthly or quarterly, and the disbursements weekly through the whole year.

In order that all the members of any actual society may be placed on a just and equal footing, it is shewn to be necessary "either, 1*st*, That all shall enter at the same age; or, 2*d*, That the difference of age shall be compensated in one way or other: And there are three ways in which later entrance may be compensated, 1*st*, By the party paying an equalising fine at entry; or, 2*d*, By paying a higher rate of annual contribution, according to his age: or, 3*d*, By receiving a lower rate of allowance †." Thus, should an annual contribution

* Errors of Actuaries, by an Actuary. Colchester, 8vo. 1s.

† Highland Society's Report, p. 81. Constable & Co. Edinburgh, 1821, 6s.

of L. 1, from an entrant at 21 years of age, be calculated to afford a weekly sick allowance of L. 1, or any other benefit, it may easily be ascertained what will be required from entrants at any later age, for the same, or higher or lower rates of allowance.

Full allowances were calculated to be paid in sickness during the whole period between 21 and 70 years of age; but, should societies wish to know the effects of varying the allowances, according to the intensity or duration of sickness, it was stated, that, although the returns to the Highland Society did not give the different kinds of sickness with sufficient precision to afford correct data for shewing those effects, yet that an approximation had been drawn from those returns, which might be adopted for ascertaining the average of the whole, until a better standard could be obtained. Thus, as formerly remarked, of 10 weeks of sickness among persons of all ages under 70, 2 might be assumed as bedfast, 5 walking, and 3 permanent,—in all 10 weeks; or, if the allowances were to be regulated by the duration of sickness, $2\frac{1}{2}$ weeks would be of the first quarter, 3 weeks of the second and third, and $4\frac{1}{2}$ weeks of unlimited duration,—in all 10 weeks. If, then, such rates were agreed to be adopted by any society, and if the allowance for

Bedfast sickness were 5s.	then	2 multiplied by	5s. would equal	10s.
Walking ditto, . 3s.		5 . .	3s. . .	15s.
Permanent ditto, 1s. 8d.		3 . .	1s. 8d. . .	5s.
		10		30s.

And which 30s. being divided by 10, would give 3s. for the uniform rate of allowance.

Again, if the allowance were, for

Sickness of the 1st quarter, 6s.	then	$2\frac{1}{2}$ multiplied by	6s. would equal	15s.
Ditto 2d & 3d do. 3s.		3 . .	3s. . .	9s.
Do. of unlimited duration, 1s.		$4\frac{1}{2}$ . .	1s. . .	4s. 6d.
		10		28s. 6d.

And which 28s. 6d. being divided by 10s. would give 2s. 10d. for the uniform rate of allowance *.

Hence by the above method, it is easy for any new society to ascertain pretty accurately the average rate of payment, and the corresponding contribution, until its own experience afford more correct data.

These preliminary points being fixed, various tables were prepared by Mr John Lyon—which were subsequently revised and approved of by several eminent calculators—for the use of Friendly Societies, with explanatory remarks as to their construction, uses, and application. In these tables is shewn the condition of the supposed society in every stage during its progress, and means are thereby afforded of instituting comparisons with the successive steps in the past or future progress of actual societies, as they advance from the lowest state of burden, with increasing capital, to the highest state of burden, when the capital ceases to accumulate, begins to decline, and is finally exhausted. From those tables the following one has been deduced.

* Highland Soc. Rep. pp. 108, 196.

TABLE shewing the Single and Annual Contributions (the latter payable quarterly) for assuring Ten Shillings per week during Sickness till 70 years of Age; Ten Pounds per annum for life after 70; and Ten Pounds at Death.*

Age.	Assurance of Weekly Pay in Sickness.						Assurance of an Annuity of £10 after 70.						Assurance of £10 on Death.						TOTAL.					
	Single Contrib.			Annual Contrib.			Single Contrib.			Annual Contrib.			Single Contrib.			Annual Contrib.			Single Contrib.			Annual Contrib.		
	L.	S.	D.	L.	S.	D.	L.	S.	D.	L.	S.	D.	L.	S.	D.	L.	S.	D.	L.	S.	D.	L.	S.	D.
21	9	1	2	0	10	0	3	2	5½	0	3	5¾	3	0	5¼	0	3	0¾	15	4	1	0	16	9¾
22	9	4	1¼	0	10	2¾	3	5	7½	0	3	7½	3	1	4½	0	3	5	15	11	1¼	0	17	3¼
23	9	7	2¼	0	10	6	3	8	11¼	0	3	10	3	2	4½	0	3	6	15	18	6	0	17	10
24	9	10	5	0	10	9¼	3	12	5¼	0	4	1	3	3	4¾	0	3	7	16	6	3	0	18	5¼
25	9	13	10	0	11	0½	3	16	1½	0	4	4	3	4	5¼	0	3	8	16	14	4¼	0	19	0½
26	9	17	4½	0	11	4¼	4	0	0	0	4	7	3	5	6½	0	3	9	17	2	11	0	19	8¼
27	10	1	0¾	0	11	8	4	4	0¾	0	4	10½	3	6	8	0	3	10	17	11	9½	1	0	4½
28	10	4	10¾	0	12	0¼	4	8	4¾	0	5	2	3	8	1¾	0	3	11½	18	1	5¼	1	1	1¾
29	10	8	10½	0	12	4¼	4	12	11	0	5	6	3	9	0¾	0	4	1	18	10	10¼	1	1	11¼
30	10	13	0¼	0	12	9	4	17	8¼	0	5	10	3	10	4	0	4	2½	19	1	0½	1	2	9½
31	10	17	3¼	0	13	2	5	2	8¾	0	6	2½	3	11	7¼	0	4	4	19	11	7¼	1	3	8½
32	11	1	8	0	13	7¼	5	8	0½	0	6	7	3	13	0¼	0	4	5½	20	2	8¾	1	4	7¾
33	11	6	5½	0	14	0½	5	13	9¼	0	7	0½	3	14	3¼	0	4	7	20	14	6	1	5	8
34	11	11	5¼	0	14	6½	5	19	9¾	0	7	6	3	15	7¼	0	4	9	21	6	10¼	1	6	9½
35	11	16	7¼	0	15	0¾	6	6	2½	0	8	0	3	16	11½	0	4	11	21	19	9¼	1	7	11¾
36	12	1	11	0	15	7¼	6	12	11½	0	8	6	3	18	4½	0	5	1	22	13	3	1	9	2¼
37	12	7	5½	0	16	2¼	7	0	0¼	0	9	2	3	19	10	0	5	3	23	7	3¾	1	10	7¼
38	12	13	2¼	0	16	9¾	7	7	7¾	0	9	9½	4	1	4½	0	5	5	24	2	2½	1	2	0¼
39	12	19	4¾	0	17	6	7	15	10	0	10	6	4	3	0¾	0	5	7	24	18	3½	1	13	7
40	13	5	9¾	0	18	2½	8	1	0½	0	11	3	4	4	6½	0	5	9½	25	11	4¾	1	15	3
41	13	12	4¾	0	18	11¾	8	13	8¼	0	12	1	4	6	1¼	0	6	0	26	12	2¼	1	17	0¾
42	13	19	2	0	19	9½	9	3	5	0	13	0	4	7	8¾	0	6	2½	27	10	3¾	1	19	0
43	14	6	0¼	1	0	8	9	13	9	0	14	0	4	9	4¾	0	6	5½	28	9	2	2	1	1½
44	14	12	11½	1	1	7	10	4	8½	0	15	1	4	11	1½	0	6	8½	29	8	9½	2	3	4½
45	14	19	9½	1	2	6¾	10	16	4¼	0	16	3½	4	12	11¼	0	7	0	30	9	1	2	5	10¼
46	15	6	10½	1	3	7	11	9	0½	0	17	7¼	4	14	8	0	7	3¼	31	10	7	2	8	5½
47	15	13	8½	1	4	8	12	2	6½	0	19	1	4	16	5½	0	7	7	32	12	8½	2	11	4
48	16	0	2½	1	5	9½	12	16	11	1	0	8½	4	18	4	0	7	11	33	15	5½	2	14	5
49	16	6	4½	1	7	0	13	12	2½	1	2	6¼	5	0	3	0	8	3½	34	18	10	2	17	9¾
50	16	12	1	1	8	3	14	8	7	1	4	6½	5	2	3¼	0	8	8½	36	2	11¼	3	1	6

The payments required for annuities to widows have been here omitted, because the tables for that scheme were calculated upon the supposition, that, in practice, all the contributions for the different benefits would be conjoined, and, therefore, that although a member should become a widower, he would still be under the necessity of making full payment to all the schemes. It is but natural to suppose, however, that few would continue to contribute to a fund from which they could never derive any benefit, and, by abandoning the society, would render all the calculations for the scheme useless. The payments for such benefits, therefore, should be entirely distinct from all other contributions, and calculated to cease at the death of the wife, as well as at the death of the husband;—but, it is presumed, that very few of the working classes will be found to insure for this benefit, the same amount of contribution being required for a widow's annuity of L. 10 per annum as for L. 100 at the death of her husband; besides, that the former benefit is uncertain, while the latter is certain, and also of more advantage to the widow.

* It was found, that an annual contribution of 10s. would afford a weekly sick allowances of 10s. 3½d from 21 to 70 years of age, but it was recommended, that 10s. only should be the stipulated allowance.

By the above table, then, an entrant at the age of 29, for a weekly sick allowance of 10s. from that age till completing his 70th year, will require to pay either an annual contribution of 12s. 4¼d. during the same period, if he live so long, or a single payment of L. 10 : 8 : 10½ at entry, to supersede all future contributions;—for an annuity of L. 10 during life after 70, either an annual contribution of 5s. 6d. till 70, or a single payment of L. 4 : 12 : 11; and for L. 10 at death, either an annual contribution of 4s. 1d. till 70, or a single payment of L. 3 : 9 : 0¾. Thus all the contributions are to cease at 70, and each member is supposed to become free (*i. e.* entitled to benefit, in the event of sickness or death) immediately upon entry; but numerous rules and problems are given in the Report, by which societies may determine—the rates of contributions or allowances, should members not become free until after a certain number of years—the effects of varying the rates of allowances according to the intensity or duration of sickness—the mode of ascertaining the stock which any society ought to be possessed of, in order to fulfil all its engagements,—and, in short, every requisite information is afforded for the proper management of Friendly Societies. For all these details, however, we must refer to the Report itself.

The tables which may next be considered, are those constructed by the Reverend John Thomas Becher, of Southwell in Nottinghamshire. This gentleman has, of late years, devoted much time and attention to the improvement of Friendly Societies, and was the founder of the Southwell Society in 1823. In his calculations, he adopted, as formerly remarked, rather a higher rate of sickness than that which had been assumed by Dr Price—the Northampton rate of mortality—4 per cent. interest on payments for allowances during sickness and old age—and 3 per cent. on those for allowances at death. The contributions in his tables were therefore higher than in those of the Highland Society. The following statement by Mr Becher will shew the difference between the two, upon the annual contributions payable by twenty-five persons, from the 21st to the 45th years of age.

Ages from 21 to 45 Years, both inclusive.	Allowance of 10s. Weekly Bed-lying Pay and 5s. Walking Pay in Sickness.			Annuity of 5s. Weekly after 70.			Assurance of L. 10 on Death.			Total.		
	Annual Contribution.			Annual Contribution.			Annual Contribution.			Annual Contribution.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Southwell Tables, . . .	19	8	9	17	15	3	9	0	0	46	4	0
Scotch Tables, ...	13	9	11½	13	0	3½	5	19	10½	32	10	1½
Excess of Southwell Tables,	5	18	9½	4	14	11½	3	0	1½	13	13	10½

Note by Mr Becher.—"The Scotch Tables give the Annual Contributions for a permanent Allowance in Sickness, without reference to Bed-lying Pay, or Walking Pay, which must be adjusted according to circumstances. Therefore I have here taken the contributions according to the Scotch Tables, for 7s. 6d. weekly permanent pay in sickness, of every denomination; assuming for our present purpose, that this equals a weekly allowance of 10s. Bed-lying pay, and 5s. Walking pay, being the medium between these two last mentioned allowances; or, in other words, that the periods of sickness entitling a member to Bed-lying pay and to Walking pay, correspond with each

other. This hypothesis advances the annual payments of the Scotch Tables for sickness higher than they ought to stand, and consequently raises the amount nearer to the Southwell Tables." ‡

It thus appears that the difference in the annual contribution is no less than 42 per cent. The tables of the Southwell Society, too, are only graduated quinquennially, while those of the Highland Society are graduated annually; that is, by the quinquennial scale, one person entering at 30 years of age, and another at 34, would both pay the same sum for the same benefit; while, by the annual scale, the payments are either increased, or the allowances diminished, for each year an entrant is older than the minimum age for entry. In this respect, therefore, the Southwell tables are certainly defective. One of the peculiarities of Mr Becher's system, however, and worthy of being imitated by such societies as combine all their payments, is, that "the tables of calculations are so framed, that whoever makes an assurance in sickness (which terminates at 65) must, at the same time, assure an annuity after 65, and a payment on death, which combination has been devised, with an intention of preventing imposition or inequality. Thus, were a sickly person to effect an assurance, what was gained in sickness would be lost in the annuity. On the other hand, should the healthy members receive but a small portion of the pay in sickness, there is a greater probability of their living to enjoy the annuities. By a similar arrangement, the annuities and the assurances on death reciprocally co-operate. If the member dies prematurely, the contributions on account of the annuity become available towards discharging the payment on death; but if the life be prolonged, the assurances on death, after a certain period, may be regarded as applicable towards the annuity. So that, by introducing a system of balanced interests, it seems scarcely possible to defraud the institution, or to preclude the attainment of its benevolent objects †."

Since the institution of the society at Southwell, several other societies have been formed in the neighbouring counties, upon a very extensive scale, and all of whom have adopted the Southwell tables. Mr Becher was very minutely examined by the Committee of the House of Commons in 1825, with regard to the calculations of these tables, and the data on which they were founded. Several objections were stated to them by some of the other gentlemen examined, particularly as to the rate of mortality and interest Mr Becher had assumed; in which objections the Committee ultimately concurred, but approved of the rate of sickness. He was again examined in 1827, and his evidence, together with the opinion of the Committee, respecting the rate of mortality, will be found in the former number of this Journal. Mr Becher subsequently communicated a set of tables to the Committee, which he had furnished to a society in Dorsetshire, and from which the following table is extracted.

With reference to this table, Mr Becher remarks, that the contributions are to be invariable, and payable once in every calendar month, till the age of 65, when the contributions for the whole benefits, as well as the allowances during sickness, are to cease. The table is founded upon the same principles as the Southwell tables, except that in this table an annual graduation of ages, and interest at the rate of 3½ per cent. have been adopted. Although the Northampton rate of mortality has still been taken, it is said that the adoption of 3½ per cent. interest, raises the contributions for sickness and annui-

* Observations on the Report of the Select Committee of the House of Commons on the Laws of Friendly Societies in 1825. Newark 1826. 4s.

† Parliamentary Report in 1825, p. 176.

ties in old age as high as if the premiums had been computed by the Carlisle tables, or those constructed upon the experience of the Equitable Society of London, at the rate of 4½ per cent. interest. It may here be remarked, however, that the single payments required from entrants to the sickness fund, seem to have been calculated upon some principle very different from that adopted by the Highland Society. By their table, p. 305 of this Journal, these payments progressively *increase* with the advance of age, whereas by Mr Becher's table they periodically *decrease*. Thus, according to him, the single payment from an entrant at 21 years of age is £1 : 17 : 3, and at 24 only £1 : 16 : 1; at 30, £2 : 8 : 5, and at 39 only £2 : 1 : 5; at 40, £2 : 6 : 9, and at 49 only £1 : 15 : 7, or 1s. 8d. below the sum payable at the age of 21. From Mr Becher's abilities as a calculator, there can be little doubt of the total results of his tables being found correct by such societies as combine all their schemes; but it is obvious that this scale of single payments for benefit during sickness could never be acted upon by societies who should keep all their payments and benefits separate—a system which it is most desirable to introduce.

TABLE shewing the Single and the Monthly Contributions for assuring Two Shillings per Week during Sickness Bed-lying Pay, and One Shilling per Week Walking Pay: a Weekly Allowance of One Shilling after the Age of 65, and Two Pounds on Death.

Age last Birth-Day.	Assurance of Weekly Pay in Sickness.		Assurance of 1s. Weekly Pay after 65.		Assurance of L. 2 on Death.		TOTAL.	
	Single Contrib.	Monthly Contrib.	Single Contrib.	Monthly Contrib.	Single Contrib.	Monthly Contrib.	Single Contrib.	Monthly Contrib.
	£ s. d.	s. d.	£ s. d.	s. d.	£ s. d.	s. d.	£ s. d.	s. d.
21	1 17 3	0 2¼	1 11 10	0 2	0 15 10	0 1	4 4 11	0 5¼
22	1 16 10	0 2¼	1 13 6	0 2	0 16 0	0 1	4 6 4	0 5¼
23	1 16 6	0 2¼	1 15 1	0 2¼	0 16 3	0 1	4 7 10	0 5½
24	1 16 1	0 2¼	1 16 10	0 2¼	0 16 5	0 1¼	4 9 4	0 5¾
25	2 3 8	0 2¾	1 18 9	0 2½	0 16 7	0 1¼	4 19 0	0 6½
26	2 3 2	0 2¾	2 0 8	0 2¾	0 16 10	0 1¼	5 0 8	0 6¾
27	2 2 7	0 2¾	2 2 9	0 2¾	0 17 0	0 1¼	5 2 4	0 6¾
28	2 2 1	0 2¾	2 5 0	0 3	0 17 3	0 1¼	5 4 4	0 7
29	2 1 6	0 2¾	2 7 3	0 3¼	0 17 5	0 1¼	5 6 2	0 7¼
30	2 8 5	0 3¼	2 9 9	0 3½	0 17 8	0 1¼	5 15 10	0 8
31	2 7 9	0 3¼	2 12 6	0 3¾	0 17 11	0 1¼	5 18 2	0 8¼
32	2 7 0	0 3¼	2 15 2	0 4	0 18 1	0 1¼	6 0 3	0 8½
33	2 6 4	0 3¼	2 18 1	0 4¼	0 18 4	0 1½	6 2 9	0 9
34	2 5 7	0 3¼	3 1 2	0 4½	0 18 7	0 1½	6 5 4	0 9¼
35	2 4 9	0 3¼	3 4 6	0 4¾	0 18 10	0 1½	6 8 1	0 9½
36	2 4 0	0 3¼	3 8 0	0 5¼	0 19 1	0 1½	6 11 1	0 10
37	2 2 2	0 3¼	3 11 9	0 5½	0 19 4	0 1½	6 13 3	0 10½
38	2 2 4	0 3¼	3 15 8	0 6	0 19 7	0 2	6 17 7	0 11¼
39	2 1 5	0 3¼	3 19 11	0 6½	0 19 10	0 2	7 1 2	0 11¾
40	2 6 9	0 3¾	4 4 5	0 7	1 0 0	0 2	7 11 2	1 0¾
41	2 5 8	0 3¾	4 9 3	0 7½	1 0 1	0 2	7 15 0	1 1¼
42	2 4 6	0 3¾	4 14 5	0 8¼	1 0 8	0 2	7 19 7	1 2
43	2 3 4	0 3¾	5 0 0	0 9	1 0 11	0 2	8 4 3	1 2¾
44	2 2 2	0 3¾	5 5 11	0 9¾	1 1 3	0 2	8 9 4	1 3½
45	2 1 0	0 3¾	5 12 3	0 10½	1 1 6	0 2¼	8 14 9	1 4½
46	1 19 9	0 3¾	5 19 1	0 11¾	1 1 10	0 2¼	9 0 8	1 5¾
47	1 18 4	0 3¾	6 6 5	1 0¾	1 2 2	0 2¼	9 6 11	1 6¾
48	1 17 0	0 3¾	6 14 3	1 2¼	1 2 5	0 2¼	9 13 8	1 8¼
49	1 15 7	0 3¾	7 2 9	1 3¾	1 2 9	0 2½	10 1 1	1 10

The sums in this table, as well as those in the one deduced from the tables of the Highland Society, are necessary for defraying the benefits, without allowing any thing for management. The Committee of the latter body, however, recommended that a sum equal to 10 or 12 per cent. on the contributions should be levied, in one way or other, for this purpose; and Mr Becher states, that, in those societies in which he has been engaged, each member must be one year in the society before being entitled to benefit, which is equal to about $6\frac{1}{2}$ per cent. on the annual contributions;—that the difference between the excess of interest received from government above that calculated in his tables, is equal to a profit of rather more than 1 per cent.;—that the difference between paying the contribution monthly, and paying it at the conclusion of the year, is equal to about $2\frac{1}{2}$ per cent;—that in converting decimals or other fractions into money a considerable surplus arises, by always making the even sums in favour of the society;—and, that fines and forfeitures are considerable sources of emolument. It is therefore assumed, that $12\frac{1}{2}$ per cent. computed upon the annual income of such institutions, or 2s. 6d. in the pound, may be applied by societies, placed in such circumstances, towards defraying the expences of management, and medical attendance; and that should the management exceed that amount, such excess must be defrayed either by voluntary donations or subscriptions, or by calling upon each member for an additional contribution *. The Committee of 1825, however, consider it as " of some importance, that the addition made for management should not be, as in some instances it is, a *per-centage* upon the contribution, inasmuch as the expence of management bears a proportion rather to the number of the members than to the amount of their payments †."

The only other table of authority for the use of Friendly Societies, is one constructed by Messrs Finlaison and Davies, actuaries. These gentlemen were required, by the Committee of the House of Commons in 1827, to construct tables, " shewing the single and monthly payments to be made by males and females respectively, of every age, from 18 to 50, to insure a weekly payment in sickness of 10s. bed-lying pay, and 5s. walking pay; and to insure also a superannuation allowance of 5s. weekly to commence at 70, at which age the sickness allowance was to cease, as well as the monthly payments of members on account thereof;—also another table, shewing the single and monthly payments to be made *till death*, by males and females respectively of every age from 18 to 50, to insure a sum of L. 10 on death." This desire was accordingly complied with, except in so far as regarded a separate table for sums payable at death, the actuaries having conceived it to be more expedient that all the three benefits should be combined.

With reference to the data on which their calculations were founded, those gentlemen remark, that the rate of sickness which they had adopted was a medium of that resulting from the returns made to the Highland Society of Scotland by Friendly Societies, and of that from the Returns made to the Adjutant General's Office as experienced by the whole Army quartered in England during the years 1823–4. Such a mean exhibits $1\frac{50}{100}$ weeks under the age of 50; $2\frac{97}{100}$ weeks from 50 to 60; and $7\frac{27}{100}$ weeks from 60 to 70.

It will here be observed, that the annual sickness at all ages between 20 and 50 is considered to be at the same rate,—Mr Finlaison being of opinion, that

* Report of 1827, p. 21. and 121.

† Report of 1825, p. 15.

whether one uniform rate of sickness under 50 be assumed, or a graduated rate, increasing according to age, the result, from the nature of the calculation, will not materially differ, as far as practical purposes are concerned. This rate of sickness under 50 is the same as that assumed for the construction of the Southwell tables; and which rate, as formerly remarked, is double the average of the sickness for those ages reported to the Highland Society.

The actuaries, although perfectly aware of the difference between the mortality of males and that of females, nevertheless determined, for several reasons, to adopt the average mortality of the two sexes,—Mr Davies taking the Carlisle observations, and Mr Finlaison the mean of what he had observed to prevail among the separate sexes of the government annuitants. They conceived that no practical danger would result from this course of proceeding, as the rates would be sufficient for any society composed of equal numbers of each sex; and rather more than sufficient in ordinary cases, as in general the males greatly predominate in Friendly Societies.

The rate of interest calculated upon is not stated, but it is presumed, from a former communication by Mr Finlaison *, to be 3 per cent. In that communication he stated, that, as Friendly Societies are subject to loss by imposition and other disadvantages, it was but proper to secure three chances in their favour. These were, 1st, To assume that money can only be improved at the rate of 3 per cent. per annum, such interest being payable half yearly; 2d, That the decrement of life among Friendly Societies should be taken at the same rate as that which prevails among the Government annuitants, who are all in the higher or better ranks of life; and, 3d, That, in calculation, no abatement ought to be made for a reduced allowance, called Walking Pay, during convalescence, or any protracted chronic illness. The savings arising from such sources, Mr Finlaison conceived should be considered as a reserved profit, to stand against imposition, or to counteract any unforeseen disaster; and in this opinion Mr Davies concurs.

Proceeding, then, upon the above data, these gentlemen made their calculations separately; and, upon the results being compared, they were found so nearly to agree, as that if an entrant, at any age between 19 and 41, were charged by Mr Finlaison's tables, according to his age at the last birthday, and by Mr Davies's tables, according to his age at next birth-day, the rate would be within one farthing of the same sum. A mean was therefore taken of their separate calculations, and the following Rules and Tables are the result.

"*RULES and TABLES recommended by* Messrs Finlaison *and* Davies, *for adoption by Friendly Societies in general.*

"The Select Committee of the Honourable House of Commons, on Friendly Societies, having required us, the undersigned Actuaries, to consult together, and jointly to recommend such a scale of rates as might be sufficient, in practice, to warrant the benefits undermentioned; we have accordingly, for the reasons set forth in the annexed paper, concurred in recommending the rates comprehended in the following brief rules, which, with ordinary precautions to prevent abuse, will, in our judgment, be found adequate to insure the objects in view.

"1. Any Society, formed for the mutual relief of its members, in sickness

* Report in 1825, p. 137.

and old age, may consist of persons of either sex; the females to be admitted on precisely the same terms as the males.—2. Its objects should be limited to Three benefits; viz. A Weekly allowance of Ten shillings in sickness, ceasing at the age of 70; a Weekly allowance of Five shillings, commencing at the age of 70, and continuing for life afterwards; and a sum of £10 for Burial money, payable whenever a member shall decease.—3. No one shall be received a member who is more than 50 years old, or who is in any degree unhealthy at the time when proposed for admission.—4. No payment shall be required from any member after the age of 70; but up to that age, every contribution is payable, whether the party be in sickness or in health.—5. Whoever is admitted at 31 years of age, shall afterwards pay a monthly contribution of three shillings and three halfpence.—6. Any one admitted younger than 31, shall pay three farthings *less* every month, for each year of age short of 31.—7. Any one admitted older than 31, shall pay seven farthings *more* every month, for each year of age above 31, and under 41.—8. Whoever is admitted at 50 years of age, shall pay seven shillings and nine-pence every month.—9. But whoever is admitted between 40 and 50, shall pay four-pence *less* every month, for each year of age short of 50.—10. None of those contributions shall ever be applied to any purpose, but to the three objects above stated: And the expence of management, and all other charges whatsoever, shall be defrayed from the subscriptions of honorary members, if any; from admission-fees and fines, or by means of separate assessments expressly made for the occasion." The following Practical Table is then given:

"*TABLE of the Single and Monthly Payments, for insuring in Sickness a Weekly Allowance of Ten Shillings Bed-lying Pay, and Five Shillings Walking Pay, ceasing at the Age of 70: An Allowance for Life of Five Shillings Weekly, after the Age of 70, and a Sum of £10 payable at Death.—The Monthly Payment to cease at the Age of 70.*

Age at last Birthday before Admission.	Single Payment.			Monthly Payment.			Age at last Birthday before Admission.	Single Payment.			Monthly Payment.		
	£	s.	d.	£	s.	d.		£	s.	d.	£	s.	d.
18	24	18	8	0	2	3½	34	33	8	5½	0	3	6¼
19	25	5	7½	0	2	4	35	34	4	4	0	3	8
20	25	13	0	0	2	4½	36	35	1	1½	0	3	9¾
21	26	0	10	0	2	5¼	37	35	19	1	0	3	11¼
22	26	3	11½	0	2	6	38	36	18	5	0	4	1¾
23	26	17	6½	0	2	6½	39	37	18	10½	0	4	4
24	27	6	7	0	2	7¼	40	39	0	4	0	4	6
25	27	16	0½	0	2	8	41	40	3	5	0	4	8¾
26	28	5	11½	0	2	9	42	41	8	6½	0	4	11½
27	28	16	3½	0	2	9¾	43	42	14	7½	0	5	2½
28	29	7	4	0	2	11	44	44	12	4	0	5	6
29	29	19	0	0	2	11¾	45	45	11	6	0	5	9½
30	30	11	4	0	3	1½	46	47	2	2½	0	6	1¾
31	31	4	6	0	3	2¼	47	48	14	4½	0	6	6
32	31	18	5½	0	3	3¾	48	50	8	5½	0	6	11¼
33	32	13	2	0	3	5	49	52	4	11	0	7	4¾
							50	54	3	3½	0	7	11

"We recommend the above, as a Practical Table, which may be

used by Friendly Societies. If any other amount of benefit than those to which it refers, should be desired, the single or monthly payments are to be increased or diminished accordingly; but the several sorts of benefits are always to bear the same proportion one to the other, which they bear in this Table.

(Signed) "John Finlaison, *Actuary of the National Debt.*
"Griffith Davies, *Guardian Assurance Office.*"

Such, then, is a brief detail of the principal rates of contributions which have been proposed for allowance to the members of Friendly Societies, during sickness, old age, and at death. Regarding the Tables in the Report of the Highland Society, the Parliamentary Committee of 1827 have given no opinion; but it is to be presumed that they concur with the Committee of 1825, in considering that the rates of sickness and mortality adopted in the construction of those tables would be unsafe to calculate upon for societies in England. The Committee, however, conceive, that either the tables of Mr Becher, or that of Messrs Finlaison and Davies, may be safely adopted by such societies, their remarks upon both being as follows:—

"On the whole, then, your Committee are of opinion, that the Dorsetshire tables, or Mr Becher's new tables, having the annual graduation, may safely be adopted; provided, 1st, That a separate provision be made for the expences of management, by fines, admission fees, voluntary contributions, or otherwise. 2dly, That the proportion of females do not greatly exceed one-third of the whole number of members. 3dly, That the assurance for a superannuation allowance be always connected with a life assurance requiring a monthly payment of half its amount. 4thly, That the present rate of interest allowed on debentures be continued.

"Your Committee are decidedly of opinion, that the societies should be formed upon the largest scale possible. It is very difficult to fix a number of members below which no society ought to exist; but if they were required to give an opinion upon this point, they would say that it would be imprudent to establish a society with fewer than two hundred members.

"It will be particularly desirable for the smaller societies, indeed it might be expedient for all new societies, to make seventy the age of superannuation; up to that age, many men are very capable of maintaining themselves by work. The payment necessary for such an allowance commencing at the age of 70, is little more than *two-thirds* of that which is required, if the allowance commences at 65. But, on the other hand, the sickness payment must be somewhat increased, if it is to provide for sickness occurring between 65 and 70. And if the superannuation be made perfectly safe, there will be no necessity to have recourse to a life assurance for supplying its deficiency. It is assuredly much better, that the contribution for each contingency should be sufficient in itself; and though your Committee agree with that of 1825, in deeming it highly important, with the view of avoiding pauperism, that a superannuation allowance should always be provided, they do not think it absolutely necessary that a sum should be assured on death.

"The actuaries, however, Mr Finlaison and Mr Griffith Davies, whom they desired to prepare tables upon these principles, have found it more expedient to combine the three contingencies; and your Committee recommend, with much confidence, the Rules and Tables of Payments which these gentlemen have prepared, with a view to their adoption by new societies." *

There are few other observations in this Report requiring here to be noticed. It is suggested that the provision in the act of 1819, requiring the tables of every society who may wish to enjoy the benefit of that act to be certified by two actuaries as correct, should be repealed;—that, for insuring accuracy, a direct reference of the rules of societies requiring sanction should be made to the National Debt Office through the Clerks of the Peace;—that returns of the states of societies' affairs should be rendered as often as the magistrates in Quarter Sessions may require, or, at any rate, once in five years;—and that the penalty in these, and all other cases of default, should be the deprivation of the benefit of $4\frac{1}{2}$ per cent. interest for their money. It is likewise suggested that the interference of two justices in petty sessions might properly be applied not only to the case of an unauthorised division or misappropriation of the funds, but to all other proceedings leading less directly to a misappropriation of the funds, particularly the admission of members beyond the age authorised by the rules, and thereby endangering the stability of the society. Lastly, the Committee concur in most of the other suggestions contained in the Report of 1825, and recommend to the House their being formed into an act, which shall likewise consolidate all the former enactments with regard to such societies as have been enrolled subsequently to the act of 1819.

To the foregoing summary a very few additional observations will at present suffice.

By the late investigations, the utility and principles of Friendly Societies have been fully developed, and means have been pointed out, by which their schemes may be as permanently and beneficially conducted as those of any of the higher classes of mutual assurance associations. Although some difference of opinion still exists as to the rates of sickness and mortality which should be adopted for the calculations of such societies, yet the data and tables that have been already procured may be safely taken as standards, until, from farther experience, more satisfactory guides can be obtained. As the tables of contributions, however, materially differ from each other, it may become a question which of them is best adapted for the practical purposes of societies; but it will be obvious that this must greatly depend upon the circumstances in which the members of any particular society may be placed,—whether situated in the country or in towns, in high or low situations; and whether engaged

* Report in 1827, p. 10.

in healthy or unhealthy, dangerous or not dangerous, employments. Any society or societies keeping these circumstances in view, and also considering the vast importance of at first securing the permanency of their schemes, may easily judge of the rates most suitable to themselves. But, even with the most correct calculation of which the subject will admit, differences between the actual and estimated expenditure will frequently occur, arising either from the members being too few in number to afford a fair average of sickness and mortality, or from epidemics, and other similar causes. "It is therefore desirable, that societies should be made fully aware, that, while correct calculation may do much in placing their schemes on a more secure footing than hitherto, still there are contingencies against which calculations made beforehand cannot guard, which can only be obviated by attention on their own part to the progress of the societies' affairs, and by accommodating their arrangements to their circumstances as occasion may require *." For this purpose, a correct record must always be kept of the society's transactions, particularly the ages of the members, and the sickness and mortality which occur at the different ages. These being known, the affairs of any society may be periodically balanced, the amount of the past and future contributions compared with the value of the future allowances, and the ability or inability of the society to fulfil its engagements correctly ascertained.

By the statute 49th Geo. III. c. 12, it is enacted, that where the rules of any society provide for all disputes between the individual members and the society being decided by arbitration, the opinion or order of such arbiters shall be final and binding on all concerned, without the power of appeal to any court whatever; and it is very properly recommended by the Committee of the Highland Society, that it should be an indispensable rule in every Friendly Society, that all disputes between the society and any of its members shall be referred to arbitration. The great utility of such a law must be evident to every one in the least acquainted with these institutions, not only on account of a great expence being thus saved both to societies and individuals, but also on account of such questions being generally more maturely considered by arbiters, than by the inferior judica-

* Highland Society's Report, p. 281.

tories to which they are limited,—a striking illustration of which shall be given in our next Number. It is not, therefore, without regret that we see it recommended by the Committee of 1825 that the law of arbitration should be repealed. If this suggestion be adopted, Friendly Societies will be deprived of one of their greatest safeguards, and be subjected to the irrevocable decisions of the Petty Sessions of the Peace, which are frequently composed of persons but very imperfectly acquainted with the principles of the contract of mutual assurance governing such institutions, and but too apt to pay little or no attention to the regulations which they themselves have sanctioned, and on which alone they ought to found their decisions.

It has been already remarked, that the statute by which Friendly Societies in England are allowed 4½ per cent. from Government for their money, does not extend to Scotland. If this important benefit is still to be granted by the statute of which notice has been already given by Mr Courtenay in the present session of Parliament, it is trusted that the Friendly Societies of Scotland will not be again excluded. If they are willing to comply with all the conditions required from those in England, it is but fair that they should be likewise entitled to the same privileges. Both kingdoms are under the same government—both are under the same system of taxation; therefore, "where all contribute alike, all should receive alike; and it is only where double benefits are wanted, that they should be refused, or paid for accordingly."

Friendly Societies are exempted by statute from all stamp-duty upon bonds granted by their treasurers; and it is presumed, that it was only from their payments being hitherto so small as not to require stamps, that they were not exempted from all stamp-duty whatever. As these societies, however, will be now upon a more extensive scale, and be managed upon the same principles with the higher assurance companies, it is to be feared that receipt, policy and other stamp duties will become a very heavy burden, and one which they will be ill able to bear. It is therefore also hoped, that this subject will not be overlooked by the legislature in the enactment of any new law for the benefit and encouragement of these laudable and highly useful institutions.

(To be continued.)

A Short Sketch of the Geology of Nithsdale, chiefly in an Economical point of View, and contrasted with that of the Neighbouring Valleys. By JAMES STUART MENTEATH, Esq. Younger of Closeburn, Member of the Wernerian Natural History Society. *

1. General account.—2. Basin of New Cumnock.—3. Basin of Sanquhar. —4. Basin of Closeburn.—5. Basin of Dumfries.—6. Upper and Lower Basin of Annandale.—7. Upper and Lower Basin of Eskdale.— 8. Annandale and Eskdale contrasted with Nithsdale.—9. Basin of the Dee contrasted with Nithsdale.

1. THE county of Dumfries is traversed from N. to S. by three rivers, viz. the Nith, Annan, and Esk. These rivers, in their course from the mountains to the Solway Firth, pass through a country in which not only the mountains, hills, and valleys, but also the rocks and soils, exhibit much to interest the geologist and agriculturist. The general features of the county have been already detailed by Professor Jameson in the "*Mineralogy of Dumfriesshire.*" We propose, therefore, in the following remarks, to confine our attention principally to the districts traversed by the river Nith.

The Nith, probably the most beautiful river in the county, rises in Ayrshire, and flows through the basin of Cumnock, in that county, into Dumfriesshire. In its progress through this county, it flows through other three basins, viz. those of Sanquhar, Closeburn, and Dumfries, before it reaches the Solway Firth.

Having described the Nith as rising in the hills of Ayrshire, and flowing through the valley of New Cumnock before it enters Dumfriesshire, it may be proper first to consider the basin of New Cumnock.

2. *Basin of New Cumnock.*—It is bounded on the west, north, and east, by greywacke, forming rather low hills, which are far from pleasing in their appearance. It is separated from the basin of Sanquhar by a ridge of greywacke, nearly three miles broad. The length of the basin is about ten miles, and the breadth five miles. The coal formation fills all the central parts of this basin, and even spreads itself on the east over the

* Read before the Wernerian Natural History Society, 9th February 1828.

sides of the greywacke hills. Coal is worked in several places. It occurs near the surface, in thick seams, from nine feet to twelve, but as yet no accurate borings have been made to ascertain the number of beds of it which this basin contains. The best sort is found at the great elevation of upwards of 1000 feet above the sea, at Mansfield, on the north side of Corsonscon Hill. The coal of Mansfield is a cubical and splinty coal, raised in very large square pieces. There are three principal beds, of nine, eleven, and twelve feet in thickness. Not far from the pits where the coal is now raised, there occurs a curious coal deposit, which appears to be a small isolated basin. This bed. which is believed to be the three above mentioned beds united into one, is no less than thirty feet thick, and is immediately under a peat-moss, which does not exceed twenty feet in thickness, and is in a complete state of decomposition.

Imbedded in the seam of coal of twelve feet in thickness, we meet with a bed of cannel-coal sixteen inches thick; and lately another bed of the same coal, twenty-two inches in thickness, has been found in an isolated situation. Both these are very free of sulphur. To the westward, nearly between the sources of the Afton and Nith, a bed of cannel coal, three feet thick, is met with, but being sulphurous, is not adapted for the preparation of gas. On the estate of Mansfield, there is a bed of glance coal or anthracite (blind coal) four feet thick.

The coal is associated with slate-clay, bituminous shale, and sandstone. The sandstone is of a yellow colour, but soft, and therefore of inferior quality.

The *carboniferous or mountain limestone* which underlies the coal of the New Cumnock basin, is found in great quantities, and may be said to fringe the coal of this basin. There are several limeworks in it, where it is burned and prepared for market. On the side of Consonscon Hill, which is greywacke, and at a considerable elevation, the limestone, which is of an excellent quality, crops out. It is burned, and supplies a great range of country, not only in this basin, but that of Sanquhar.

On the banks of the Afton, one of the tributaries of the Nith, before it leaves the New Cumnock Basin, galena or lead glance occurs in transition rocks, and has been wrought for a considerable time, but to no great extent.

The soil of New Cumnock Basin is clayey, stiff and tenacious, such as is generally found covering the coal formation. The herbage, though abundant, is coarse. It is, however, well adapted for the food of the dairy cow; and, accordingly, the farmers of this basin have availed themselves of this natural advantage of their situation, and employed the lime which is found every where at hand in ameliorating the soil, and improving the pasture. Much has been ploughed far up the hills, and artificial grasses introduced; and, following up this system, they have, by great care and expense, collected a breed of the Cunynghame or Dunlop cow, a small short horned animal, unequalled, perhaps, by the breed of any other district of Ayrshire. They make great quantities of butter and cheese, which is exported to all parts of the kingdom.

The Basin of New Cumnock, though described as one of the series of basins in the course of the Nith, cannot correctly be viewed as a separate coal formation, but as forming a part of that of the great basin of the Ayr, which extends from Muirkirk, (where great quantities of argillaceous carbonate of iron are found, raised, and smelted), all the way to the sea, including the greatest part of the county of Ayr, which great coal-field is separated from that of the Clyde and Forth by a narrow ridge of the Strathavon and Loudon Hills.

It may not he uninteresting to state, that, not far from the borders of the New Cumnock Basin, near Old Cumnock, *graphite* is found in considerable quantity in the coal formation *, and it might probably be found in this basin also.

Notwithstanding the great abundance of coal in the New Cumnock Basin, the demand for it has been inconsiderable, owing to its being thinly inhabited, and opening on the north and south into a coal country. In one instance, however, the case has been different. A coal occurs near the source of the Nith at Auldknow, considered excellently adapted for the working of iron. With this view, therefore, it is carried in considerable quantity over a great part of the counties of Ayr, Dumfries and Kirkcudbright, often to a distance of fifty or sixty miles, thus forming the

* A Geognostical description of the Cumnock Graphite will be found in Professor Jameson's Mineralogical Description of Dumfriesshire, pp. 158–162.

chief export from this basin. But, as the road communicating with Dumfriesshire to the eastward of Consonscon Hill is repaired, and having a considerable descent all the way to Kirkconnel, it is probable that the Mansfield coal situated in this basin will be consumed in Nithsdale. This coal is very carbonaceous and highly bituminous, with little or no pyrites. Its unsulphurous nature renders it a most valuable article to the gas-maker, maltster, lime-coke burner, smelter of ores, and to all who indispensably require purity of fuel in their operations. It is at present employed to prepare the gas for lighting the streets of Dumfries, though at a distance of more than thirty miles; and its coke is carried as far as Ayr.

3. *Basin of Sanquhar*.—The river Nith, after leaving the Basin of New Cumnock, crosses a greywacke ridge through rather a narrow ravine, and enters the Basin of Sanquhar. In this ridge amygdaloid occurs. The hills which surround this basin are of greywacke. They are loftier, and of more pleasing form than those of New Cumnock. The Killa, the Youchan, the Crawick, and the Menock, have their sources among them, and in their course, before falling into the Nith, afford sweet pastoral scenery.

The secondary rocks in the Sanquhar Basin are the *coal formation*, and *secondary trap*. The *coal formation* occurs only on the bottom of the basin. It stretches along both sides of the Nith for about seven or eight miles, but scarcely exceeds two miles and a-half in width. Its position is very irregular. The strata are frequently broken, thrown down, and, as the collier expresses it, are full of troubles. They are crossed by two dikes or veins of *secondary trap or greenstone*, which, in their course, alter the position of the strata. Near to these dikes the coal is charred, and of inferior quality.* The coal of this basin has a splinty character, is generally sulphureous, and leaves a great quantity of slaty ash after combustion. Of the twelve beds, † ascer-

* Professor Jameson remarks, that a little above Crawick Bridge, there is a bed, about four feet thick, of *columnar glance-coal or graphite*: it is traversed by a vein of greenstone.—*Mineralogy of Dumfriesshire*, p. 89.

† According to the survey made by Mr Maclaren.

tained by borings in different parts of the basin, the thinnest is only a few inches, and the thickest does not exceed five feet.

At the north-west corner of this basin, a kind of coal is found, which is considered of a superior quality, and is chiefly employed by blacksmiths. A small deposite of limestone, with coal, occurs near the Menock, and appears separated from the coal-field of Sanquhar by a ridge of greywacke. It is of such an impure quality as to forbid its use in agriculture. The ochry sandstone of the coal-field occurs on both sides of the Nith. That which is on the east side of the river is of a bad quality, hardly turning wet; but that which is found on the west side, as near the mouth of the Youchan, of a yellow-whitish colour, is an excellent building material.

Some traces of iron-ore are observed near Crawick Bridge, but as yet this ore has not been turned to account.

The soil of the valley of Sanquhar is clayey, partaking of all the properties of that which usually lies upon the coal formation. It is stiff, tenacious, and impervious to water, requiring much drainage, and much liming, to loosen its texture, and fit it for the growth of good herbage. It is, however, distant from lime, a circumstance which has hitherto retarded its improvement. There is little or no wood in this valley, which makes the climate bleak and the scenery uninteresting.

The Sanquhar coal formation, though of no great extent, has long supplied a considerable range of country, as it has afforded a principal part of the fuel of Dumfries and the neighbourhood *. But, it is probable that in future the extension of market of the Sanquhar coal will not be increased, the Ayrshire coal being now accessible, and the lower part of Nithsdale deriving a

* That this coal-field, though of but very limited extent, is fitted to supply the district in which it is placed for a very long period, a short calculation will be sufficient to show.

It has been stated, that the coal-field of Sanquhar is about 8 miles long, and scarcely 2½ in breadth. This will give in all about 20 square miles, or 13,000 square acres. Now, the seams of coal, which are twelve in number, as has been ascertained by accurate borings, amount in all to only 18 feet in thickness. But of these several are only a few inches thick; and the four workable seems scarcely amount to more than 15 feet or five yards. Taking, then, the workable coal at this thickness, or nearly so, it will give us in each acre 24,200 cubic yards of coal, or in all 314,600,000 cubic yards. But each cubic yard of coal, as I have been informed by an experienced engineer, Mr

considerable supply from England, since the navigation of the Nith has been improved.

Lying to the eastward of the valley of Sanquhar, in the grey wacke mountains, are the great lead-mines of Wanlockhead and Leadhills. The former are in Dumfriesshire, and the property of the Duke of Buccleuch; the latter, belonging to the Earl of Hopetoun, are in Clydesdale. The principal ore at both places is galena or lead-glance, which is found in great quantities. Specimens of many of the more beautiful and rarer of the spars of lead are met with; * and, of late years, mineralogists have described new species of lead spars as natives of these mines. Silver is contained in the lead, and about 7 or 9 ounces of it can be extracted from the ton. In 1809, the produce of the mines of Leadhills was 25,000 bars,—of Wanlockhead, 15,000 bars, each weighing 9 stones avoirdupois, and the price being L. 32 the ton, the gross produce exceeded L. 80,000 in that year. Since that period, I believe the annual returns have been far below those of the year 1809. They must, however, since they were opened, have yielded millions of revenue.

Gold is found in the sand of the streams in the vicinity of these mines. By washing the sand, the miner in his leisure hours collects a small quantity of this precious metal. It is said

Bald, may be considered as about 18 cwt., and, therefore, in each acre there will be about 22,000 tons of coal. But, deducting even ¼th for pillars left in working the coal, which is the utmost ever lost, we shall have of coal for use 16,600 tons in each acre.

Now, it has been ascertained from accounts of the sales, that not more than 13,000 tons are annually required for the whole district. One square acre would therefore supply this demand for one year and a quarter; and, consequently, the 20 square miles, or 13,000 square acres, will be sufficient for upwards of 16,000 years. But, deducting 1000 acres for that which has been already wrought, and for whinstone-dikes, and such like in this field, we shall have 12,000 acres still to break, which, according to the highest rate of demand that has hitherto taken place, will supply this district for 15,000 years, a period much more than twice as long as that since man has yet existed.

But, if we take into account the coal of the New Cumnock Basin, which, though not hitherto accurately ascertained, seems to be much more extensive than that of the Sanquhar, the treasure of fuel which this district of Nithsdale possesses, appears almost unlimited, according to the present rate of demand.

* A fine collection of these has been made by the company at Wanlockhead, and may be seen on application to the overseers.

that, in the reign of James V., as much as amounted to the sum of L. 100,000 was obtained in one year.

It is very interesting to observe, that this spot, not more than two miles each way, in the county of Dumfries, where a hut would perhaps scarcely have been seen but for the mineral treasures there deposited, has for more than a century supported an industrious and comfortable population. The miners at Leadhills have a library of 1200 volumes. At Wanlockhead is another of 700 volumes.*

The intelligence of the miner is well exemplified by the skill with which he cultivates his small plot of ground. Elevated as is his residence, by industriously raising the Alopecurus pratensis, or the Meadow foxtail, he has early in the spring green food to give his cow before the lowland farmer.

The rocks which separate the Sanquhar and Closeburn basins assume more the appearance of greywacke slate than in most other parts of the range. The stratification is in many places nearly vertical, and runs from NE. to SW. The stratification is very loose, having the seams filled with a red ochrey earth, which is found principally in this quarter. At Burnmouth, a place about the middle of this ridge, which separates the basins of Sanquhar and Closeburn, it has the appearance of indifferent slate; and at Arkland, in the parish of Tynron, a few miles to the west, slates for roofing have been raised. Thus there seems a slaty structure to extend from Glenochar, a slate quarry in Lanarkshire, across the whole of Dumfriesshire in this direction.

4. *Basin of Closeburn.*—The river Nith, after a tumultuous course of more than five miles through a rocky channel, exhibiting scenery of the most romantic kind, and beautifully adorned with a great variety of natural wood, enters the basin of Closeburn, which is completely encircled by greywacke hills, that exhibit a pleasing outline. Of these the Lowders are the most striking. They rise to a considerable elevation, with a smooth grassy slope to the west; and, by means of a road now opened through them into Lanarkshire, afford one of

* These volumes, in the wild regions of the Leadhills, we believe, are more thoroughly read, and more anxiously sought after, by the poor miners, than are the numerous and splendid volumes in many of the libraries in the low country: hence these people are comparatively well informed.

the most picturesque passes in the south of Scotland. This is denominated the Pass of Dalveen. By much ingenuity and labour, a beautifully winding road has been cut out along the sides of the mountains; and from the great height to which it gradually conducts, the traveller, with no little trepidation, looks down on a small stream or burn, winding like a silver thread, about 300 feet beneath him.

Nowhere, perhaps, in Great Britain is a scene more pleasing, more placid, more interesting, presented, than in this long, narrow, mountain pass. The sides of its hills, without any clothing of wood, are smooth, covered with a short velvet turf, fresh and green during the greater part of the year, affording abundance of food to the flocks which graze their declivities. In the bottom of the valley, between these agreeably shelving hills, is the Carron Water, here but a small rivulet, pure and limpid, and, like the many other burns of Scotland, characterizes and enlivens this romantic dell.

Few more delightful scenes are offered to the lover of landscape, than he will enjoy in lingering in this beautiful pass of Dalveen, in a calm summer's evening, when the lights and long shadows of a setting sun fall on its mountain sides, enlivened by numerous variously grouped flocks.

To the southward of Dalveen, in the same range of hills, the Lowders, is another pass, called the Walpath, communicating with England and the northern parts of Scotland, through which the Romans carried their road, and of which traces still remain. This road, scarcely at present more than a tract, passes close to the village of Durisdeer, in the church of which the traveller will be interested by some fine sculpture in the tomb of the Queensbery family. It is, however, far inferior in wild picturesque scenery to that of Dalveen; and, offering many obstacles to the modern road-engineer, was deemed by him unfit for opening a communication through the Lowders into Lanarkshire. Dalveen Pass was therefore preferred; and happy it is for the traveller that utility and sweet pastoral scenery could be united.

There is more wood in this basin than in the two we have just described; the banks of the Carron, the Cample, the Scar, and the Shinnel, tributaries of the Nith before it quits the valley of Closeburn, being all beautifully fringed with natural wood.

The bottom of the valley of Closeburn is covered with secondary rocks. These are *sandstone* and *limestone.* The most abundant rock is sandstone. Of it there are three varieties, the red, white, and grey. The red appears to be the *new red sandstone,* and is by far the most abundant. It varies much in its texture, being sometimes hard, but oftener soft and friable. It lies over all the other strata of the basin, but is almost entirely confined to the east side of the Nith, as scarcely any of it is seen on the west. One of the best examples of the appearance of its varied structure, and the irregularity of its dip, may be seen at the Gateley Bridge Quarry on the Cample, where this red sandstone exhibits its beds lying in all manner of directions, horizontal, upright, and variously inclined. In this quarry roofing-flags are raised, which are carried to a great distance, and even exported to England. Being pervious to water, they are unfit for roofing until they have been brushed over with coal-tar, when they become an excellent substitute for slate. Not only flags for roofs, but also lintels of doors, windows, &c. are here prepared, and supply the whole neighbourhood. At Crigup Linn the new red sandstone covers the other strata of the basin, which are to be seen rising from underneath it. The red sandstone, easily worn away by the running water, is at the Crigup Linn, by the continual chaffing of the Crigup, scooped into a very deep ravine, its sides presenting rocks of every picturesque form, and overhung by rich foliage. It was to this romantic dell that the unjustly persecuted Covenanters fled for shelter in their desperate fortunes. And the pen of the inimitable Sir Walter Scott has lately given this linn a classic interest, by having, in his tale of Mortality, made the Crigup Linn the retreat of the daring Balfour of Burleigh.

The red sandstone of this valley is, in general, a good building stone. The most esteemed is that raised at the Gateley Bridge quarry, where it is hard, tough, and very durable, resisting, in those houses built of it, the action of the weather, and indicating no appearance of waste or decay. Other but less frequent varieties of this sandstone, are soft, and decay on exposure to the weather. Of this a striking proof may be adduced in the case of Drumlanrig Castle, which was built at the same time with Heriot's Hospital, by the same architect Sir

Inigo Jones, but is in a decayed state compared with that building.

Not far from the Gateley Bridge, red sandstone quarry, a mile up the Cample, basalt occurs in pentagonal columns. It appears to form a narrow ridge or dike, traceable from Morton-Mains Hill on the north-east of this spot, and it seems to take the direction of the Linburn Hill on the south-east*.

The white and grey sandstones, under the red sandstone, are not found in any considerable quantity. The *white*, which occurs very seldom, is hard and compact in its texture, and well fitted to resist the effects of the weather. Of the *grey* more is found, and it partakes much of the characters and qualities of the white.

The limestone is found only at the south end of the basin of Closeburn on both sides of the Nith, as at Closeburn and Barjarg, but at the latter in much less quantity

(To be concluded in our next Number.)

A Proposition for carrying on a Course of Experiments, with a view to constructing, as a National Instrument, a large Refracting Telescope, with a fluid concave Lens, instead of the usual Lens of Flint Glass. Addressed to his Royal Highness the Lord High Admiral, and the Right Honourable and Honourable Members of the Board of Longitude. By PETER BARLOW, F.R.S. *Mem. Imp. Ac. Petrop., &c. &c.*

[This Memoir has been presented to the Board of Longitude; and we are gratified to add that the members have ordered the experiments to be pursued. Mr Barlow is accordingly, as another step, attempting an eight inch aperture, of ten feet in length, but with a focal power of about sixteen feet.]

IN a memoir I had the honour to present to the Royal Society in the early part of the year 1827, which was published in the

* In this valley there are no fixed rocks of granite, and indeed none nearer than perhaps thirty miles. It is very curious, however, that there are rounded blocks of it found in many places on the surface, some of them exceeding a ton in weight. The same occurs in other districts, where the distance from the granite formation is still greater, as in Cheshire. The existence of these masses in such situations, has never yet perhaps been satisfactorily accounted for. Two explanations have been offered; according to the one, they are of lacustrine origin—while the other connects them with the Mosaic deluge.

last Part of the Philosophical Transactions, I have given an account of a series of experiments I made, assisted by the practical skill of Messrs W. and T. Gilbert, instrument makers to the Honourable East India Company, on the construction of refracting telescopes; in which memoir I have also described a new instrument for simplifying the determination of the dispersive power of glass, and I am in hopes that I have so far succeeded in removing from the several formulæ those terms which involve quantities too refined to be followed out in practice, that no difficulty of calculation can be said to remain in the construction of this instrument: nor is there any practical one which the ingenuity of our opticians would not overcome, provided glass could be obtained of sufficient size and purity. But here, unfortunately, an impediment interposes; and therefore, with a view to avoid an obstacle we have not at present been able to overcome, I turned my attention to the adoption of some fluid to supply the place of the flint lens. The construction of flint object glasses, retaining, however, the flint lens, had been formerly attempted by Dr Blair with considerable success, but which, for some reason, was not afterwards pursued *. I was not at first fully aware of the fluid employed by this ingenious philosopher, and moreover it was at least possible that some other might be found equally well, if not better, suited to the purpose. I therefore determined to begin *de novo*, and ascertain with my new instrument, which was easily made applicable to the purpose, the refractive index and the dispersive power of every fluid which appeared to possess properties likely to answer my intended purpose. I had proceeded some way in this inquiry, with several oils, acids, &c., when I made trial of the sulphuret of carbon, and here I found at once a fluid which appeared to possess every requisite I could desire. Its index being nearly the same as that of the best flint glass, with a dispersive power more than double, perfectly colourless, beautifully transparent, and, although very expansible, possessing the same, or very nearly indeed †,

* It appears from an article published since this was written, that Mr Blair, the son of Dr Blair, is at present engaged in pursuing his father's views.

† I have never found any appreciable numerical difference in the refractive index of this fluid between the temperatures of 31° and 84°, the fluid being hermetically sealed.

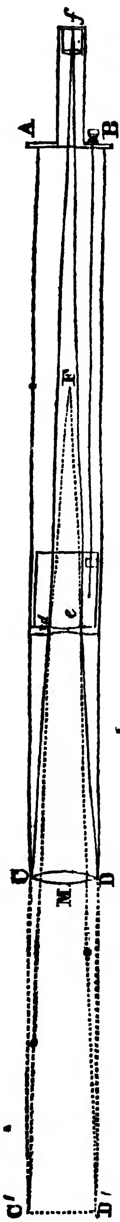
the same optical properties under all temperatures to which it is likely to be exposed in astronomical observations, except perhaps direct observations on the solar disc, which will probably be found inadmissible. I felt so confident, from the result obtained with the dispersive instrument, of the applicability of this splendid fluid to the purposes I had in view, that after some trials as to the best method of inclosing it, and of applying the correcting lens, I attempted at once a telescope of six inches aperture and of seven feet length; but some unforeseen difficulty having interposed, after several unsuccessful trials, I laid it by, and undertook one of three inches aperture. I was here more fortunate, having, with this instrument in its first rude experimental form, without any adaptation or selection of glasses, separated a great number of double stars of that class which Sir William Herschell has pointed out as tests of a good three and a half inch refractor; I can see with it the small star in Polaris with a power of 46, and with the higher powers several stars which are considered to require a good telescope, as, for example, 70, p Ophiuchi, 39 Bootis, the quadruple star ε Lyræ, ζ Aquarii, α Herculis, &c. Encouraged by my success on this instrument, I again attempted the six inch object glass, with a different manner of adjusting and securing the lenses; and the result of my endeavours I lay with confidence before the Board of Longitude, feeling convinced that every proper allowance will be made for the imperfections of a first attempt, at a novel construction, on a considerable scale, and which professes only to prove the applicability of the principle, and not the completion of the experiment. With this instrument the small star in Polaris is so distinct and brilliant with a power of 143, that its transit might be taken with the utmost certainty. But as this and the former instruments are both before the Board of Longitude, and have been examined by some of its members, I would much rather they would report their opinion of the performance of them, and more particularly of the promise they hold out, than to give my own. I shall therefore proceed at once to describe the principle of the proposed construction, which possesses some novelty, and offers some advantage not to be obtained with any glass ever made, or likely to be made; although I am quite ready to admit, that if glass could be obtained of sufficient purity and size, the permanent nature of that material would, probably,

give it a preference before any other in the construction of refracting telescopes. My object is (as I wish distinctly to be understood) not to supplant the use of flint glass in the construction of this instrument, but to supply its place by a valuable substitute in cases where the former cannot be obtained sufficiently large, or where it can only be obtained at an expence which must always limit the possession of a good astronomical telescope to persons of fortune and to public institutions.

Principle of Construction.

In the usual construction of achromatic telescopes, the two or three lenses composing the object-glass are brought into immediate contact, and in the fluid telescope proposed by Dr Blair, the construction was the same, the fluid having been inclosed in the object glass itself. Nor could any change in this arrangement in either case be introduced with advantage; because the dispersive ratio between the glasses in the former instance, and between the glass and fluid in the latter, is too close to admit of bringing the concave correcting medium far enough back to be of any sensible advantage. The case, however, is very different with the sulphuret of carbon. The dispersive ratio here varies (according to the glass employed) between the limits ·298 and ·334; which circumstance has enabled me to place the fluid correcting lens at a distance from the plate lens equal to half its focal length; and I might carry it still farther back, and yet possess sufficient dispersive power to render the object glass achromatic. Moreover, by this means the fluid lens, which is the most difficult part of the construction, is reduced to one-half, or to less than one-half of the size of the plate lens; consequently, to construct a telescope of ten or twelve inches aperture involves no greater difficulty in the manipulation, than in making a telescope of the usual description of five or six inches aperture, except in the simple plate lens itself; and, what will be thought perhaps of greater importance, a telescope of this kind of ten or twelve feet length, will be equivalent in its focal power to one of sixteen or twenty feet. We may, therefore, by this means, shorten the tube several feet, and yet possess a focal power more considerable than could be conveniently given to it on the usual principle of construction. This will be better understood from the annexed diagram.

In this figure A B C D represent the tube of the 6 inch telescope, C D the plate object glass, F the first focus of rays, *d e* the fluid concave lens, distant from the former 24 inches. The focal length M F being 48 inches, and, consequently, as 48 : 6 : : 24 : 3 inches, the diameter of the fluid lens. The resulting compound focus is 62·5 inches; it is obvious, therefore, that the rays *d f*, *e f*, arrive at the focus under the same convergency, and with the same light as if they proceeded from a lens of 6 inches diameter, placed at a distance beyond the object glass C D, (as C′ D′), determined by producing these rays till they meet the sides of the tube produced in C′ D′, viz. at 62.5 inches beyond the fluid lens. Hence, it is obvious, the rays will converge as they would do from an object glass, C′ D′, of the usual kind, with a focus of 10 feet 5 inches. We have thus, therefore, shortened the tube 38·5 inches, or have at least the advantage of a focus 38·5 inches longer than our tube; and the same principle may be carried much farther, so as to reduce the usual length of refracting telescopes nearly one-half, without increasing the aberration in the first glass beyond the least that can possibly belong to a telescope of the usual kind of the whole length. It should, moreover, be observed, that the adjustment for focus may be made either in the usual way, or by a slight movement of the fluid lens, as in the Gregorian reflectors, by means of the small speculum. In the latter case, the eye-piece is fixed, which may probably be convenient for astronomical purposes, in consequence of the great delicacy of the adjustment.



Thus far every thing is in favour of the proposed construction; but some doubtful points may probably present themselves, viz. Is not the opening of the lenses to so great a distance calculated to produce an irrationality in the two spectra;

or, is there not in the beginning such an irrationality? Secondly, May there not be a great loss of light by reflection at the second lens, considering the density of the rays at the place of incidence? The best reply to these questions is a reference to the two telescopes already constructed, which exhibit no remarkable defect of either kind *, at least that I am aware of; on the contrary, with regard to the latter, the quantity of light is rather in excess than in defect, compared with the usual construction. Other queries relative to the ultimate success of this proposition may also reasonably be anticipated; as, for example, can the fluid be permanently secured? and, if so, Will it preserve its transparency, and other optical properties? Will it not act upon and destroy the surface of the glass, &c.? To these and similar queries I reply, that, with any particular fluid which has not been submitted to these trials, experience is the only test we can have. Our spirit levels, spirit thermometers, &c. show that some fluids at least may be preserved for many years, without experiencing any change, and without producing any in the appearance of the glass tubes containing them. I beg, however, to add, that, should any of these happen except the last, nothing can be more simple than to supply the means of replacing the fluid at any time, and by any person, without disturbing the adjustment of the telescope; and the same means may be resorted to (if they should be found necessary in constructing a very large instrument), to prevent the external pressure of the atmosphere distorting the figure of the glasses containing the fluid. Such experiments as these, however, and the construction of an achromatic fluid refracting telescope, with a proper stand, on the scale which I feel every confidence in being able ultimately to accomplish, viz. one of at least 12 or 14 inches aperture, involve expences which can only be conveniently borne by men of fortune and public institutions. I have therefore done myself the honour to submit my proposition, with the results already obtained, to the Board of Longitude; and if these *first* results, although not every thing that could be wished, should still be such as to prove the practicability of the Proposition, and

* Mr Barlow has since presented a Memoir to the Royal Society, illustrating, on theoretical principles, the tendency of this construction to destroy the secondary spectrum, an imperfection inseparable from the usual form of refracting telescopes.

to justify farther attempts, I have no doubt the Board will, as far as is consistent with its constitution, forward the prosecution of the experiments, and ultimately the construction of an achromatic telescope, which shall exceed in aperture and power any instruments of the kind hitherto attempted. It is hardly necessary for me to add, that in such case it will give me great satisfaction to undertake the direction of these operations, with the aid of Messrs W. and T. Gilbert, to whose liberal and scientific views, as well as to their practical skill and ingenuity, I have been much indebted for having thus far proved the practicability of my proposition.

PETER BARLOW.

ROYAL MILITARY ACADEMY, }
13th October 1827. }

On the Principal Causes of the Difference of Temperature on the Globe. By Baron ALEXANDER VON HUMBOLDT. *

THE distribution of heat over the globe, has for many years formed one of the principal objects of my researches. This subject is intimately connected with the local differences of the productions of nature, with the agriculture and the commercial intercourse of nations, and even, in several respects, with their moral and political situation. The time is past when we were satisfied with some undefined views on the difference of geographical and physical climates, and when all the modifications of temperature were ascribed either to the shelter afforded by ridges of mountains, or to the various elevations of the surface of the earth. We have seen, that the remarkable differences of climates which we perceive in large tracts of country, under the same latitude, and on the same level above the surface of the sea, do not arise from the trifling influence of individual localities, but that they are subject to general laws, determined by the form of the continents in general, by their outlines, by the state of their surface, but particularly by their respective positions, and the proportion of their size, to the neighbouring seas. The

* Extract from a public Lecture delivered in the Royal Academy at Berlin, on the 3d of July 1827.

relative position of the transparent and opaque, of the fluid or solid parts of the earth, modifies the absorption of the solar rays falling under the same angles, and at the same time the production of heat. These circumstances, the winter cover of ice and snow, which is peculiar to the continents, and to a very small part only of the seas; the slowness with which large masses of water are heated and cooled; the radiation from smooth or rough surfaces, towards a cloudless sky; the regular currents of the ocean and of the atmosphere, by which water and air from different latitudes and different depths and heights are mixed; all concur to produce the peculiarities of climate. It may therefore be said, that every place has a double climate, one depending on general and remote causes, on the general position and shape of the continents, and another determined by the peculiar relations of its locality.

Since the problem of the geographical distribution of heat has been considered upon general principles, meteorological observations have been conducted in a more efficient manner. A smaller number of them now lead to certain results; and the discoveries made within the last twenty years, in the most remote parts of the globe, have gradually enlarged the point of view. Physical and geological inquiries have now become equally important objects of all extensive voyages and travels. To begin with the extreme north, I shall here, in the first place, mention a man, whom the dangerous and troublesome occupations of whale-fishing, which were the object of his voyage, have not prevented from carrying on the most refined meteorological and zoological observations. Captain Scoresby has, for the first time, determined the mean atmospheric temperature of the Polar Seas, which he has taken between the volcanic Island of Jan Mayen, and that part of East Greenland discovered by himself. In endeavouring to discover a north-west passage, the English government has succeeded in affording to geography, to climatology, and to the theory of magnetism, services which were originally promised to the commercial interest of nations. Parry, Sabine, and Franklin have, for several years, been employed in investigating the temperature of the atmosphere, and of the sea, in the polar regions; they have penetrated to Port Bowen and Melville's Island, consequently nearly to

75° N. Lat.; and they have, in this arduous task, displayed a perseverance, of which we find hardly a parallel instance in the history of human exertions and struggles against the elements. Captain Weddell has recently destroyed the ancient prejudice, sanctioned by Cook's illustrious name, that the South Pole is, on account of a more extended mass of ice, less accessible than the North Pole. The discovery of a new archipelago to the SSE. of Terra del Fuego, has led to an expedition in which Captain Weddell found a sea completely free from ice, under the 74° Lat. (far beyond two solitary islands discovered by the Russian Captain Billinghausen.)

In turning to the temperate zone, we find a great many points where the average temperature, which hitherto was considered to be invariable, has been measured. Various astronomers in New Holland, and on the foot of the Indian Himalaya, Catholic and Protestant missionaries at Macao, in Van Diemen's Land, and in the Sandwich Islands, have furnished us with new facts towards comparing the northern and southern, the eastern and western hemispheres, in the torrid and temperate zones, consequently those parts of the globe which are most abundant in water, as well as those which are most abundant in land. In the same manner, the proportion of heat under the line, and in both the tropics, has been determined. These points, as ascertained in numbers, are particularly important as fixed points, because they may, like the zone of the warmest sea-water, (between 84° and 87° Fah.; 23° and 24° 5′ R.), in future ages serve to determine the much disputed variability of the temperature of our planet.

It is necessary to mention here, that we have been long in want of climatological determinations in the most southern parts of the temperate zones, between the 28° and 30° lat. This part of the world forms as it were an intermediate link between the climate of Palms, and that region in which, according to the tradition of the east, mankind, along the Mediterranean, in Asia Minor, and Persia, first awoke to intellectual developement, to mild manners, and to taste in the cultivation of the arts. The observations of Niebuhr, Nouet, and Coutel in Egypt, those of my unfortunate friend Ritchie in the Oasis of Murzuk, could, on account of local circumstances, only lead to

erroneous results. The large and classical work on the Canary Islands, for which we are indebted to Mr Leopold Von Buch, has now also filled up this blank, in the same way as his travels in Lapland and to the most northern promontory of Europe, first furnished us with a clear illustration of the causes which, in the Scandinavian peninsula, beyond the polar circle, diminish the severity of the winter cold, and preserve to the springs the temperature which they had received from deeply seated strata, and which occasion, under the influence of a continental climate and that of the coast, an unequal elevation of the snow line, and of the upper limit at which different species of trees grow.

If we follow the current of the sea, which traverses the great valley of the Atlantic Ocean, from east to west, we find almost unexpectedly rich sources of instruction in the New World, from Russian America, and the settlements of the Canadian hunters, to the River La Plata, and the most southern parts of Chili. It is no longer foreign naturalists who communicate to us the notices they have been able to collect during a short residence in plains, rich in wood and grass, and on the ice-covered ridges of the Cordillera; we have no longer need to judge of the mean temperature of the whole year by that of single months or weeks; here we obtain every where solid and complete information from the inhabitants themselves.

The executive power of the United States of North America has ordered meteorological observations for five years to be made three times a day, at seventeen different points, occupied by military garrisons, between the 28° and 47° lat., between the Missouri and the Alleghanys, the lake Michigan, and the coast of Pensacola; and from these observations, the average temperature of days, months, and of the whole year, is drawn. These observations calculated by Mr Lovell, surgeon-general of the army, have been published at the expense of the American government, and have been distributed to all scientific institutions in Europe. If this excellent example was followed in the eastern part of our continent, and if, by the command and at the expence of a powerful monarch, similar comparative theometrical observations were carried on in well selected points in the extensive district situated between the Vistula and the Lena, the

after Dr Oudney's death, the temperature of the air was not below 49° Fahr. (7½° R.). In South America, at a less distance from the equator, near Bogota and Quito, I saw the water free from ice, at the height of 8500 and 9000 feet, notwithstanding the strong effect of the radiation of high plains in producing cold. In the manuscripts of young Beaufort, who died lately in Upper Senegal, a victim to scientific zeal, I find that under the 16th degree of latitude, the thermometer marked in the shade on the same day 113° Fahr. (36° R.) at noon, and 59° Fahr. (12° R.) early in the morning. The temperature of the air in the plains of America never sinks so low in the same northern latitude. In laying before the Academy last year, a detailed account of the excellent labours of Ehrenberg and Hemperich, I have already mentioned the cold to which these learned travellers were exposed, when in the Desert of Dongola under the 19th degree of latitude. North winds penetrated into this southern tropical country, and, in December, the thermometer sunk to 38° Fahr. (2° 5′ R.) above the freezing point, consequently 12° of R. lower than it had ever been observed, under the same latitude, in the West Indies, according to the accounts carefully collected by myself. It is astonishing to find Africa in its deserts colder than America, with all its rich vegetation, and this not on the margin of the tropics, but at the very centre of them. The true causes of this singular cooling process have not yet been sufficiently explained. Perhaps it is the radiation of heat from the soil through the dry air towards a cloudless sky, or a sudden expansion produced by the pouring of humid strata into this dry air, and the descent of the upper parts of the atmosphere.

It is generally known that more than two-thirds of our planet are covered by a body of water, which, by its contact with the atmosphere, exercises the most powerful influence upon the climate of the continents. The rays from the sun produce heat according to different laws, as they fall either upon the water or upon the solid surface of the earth. The mobility of the particles of which we imagine fluid bodies to be composed, produces currents and an unequal distribution of temperature; cooled and condensed by radiation, the particles of water sink to the bottom. By ascending in balloons, climbing upon insulated peaks of

mountains, by thermoscopic apparatus sunk into the sea, it has been possible to determine the velocity of the cooling process which takes place at different seasons, from below upwards, in the atmosphere, and from above downwards, in the ocean, and in fresh water lakes. The animals, therefore, which dwell in both these elements, find on each point of the globe, in the aeriform and liquid elements, the most heterogeneous climates, placed in strata one above another. In the depth of the sea, under the Line, and in alpine lakes of the temperate zone, there is always a fixed degree of cold, viz. that degree at which the water attains the greatest density. The experiments of Ellis, Forster and Saussure, have been repeated under all zones and in all depths; but what we know of the lowest temperature of the air, and of sea-water, as well as of the greatest effect of the radiation of heat between the tropics, serves as an infallible proof that the cold which there exists near the bottom of the sea, is produced by a current which, in the depths of the ocean, passes from the poles towards the equator, and cools the inferior strata of water in the southern ocean, like the current of air in the upper atmosphere, which moves from the equator to the poles, to temper the cold of the winter in the northern regions.

The immortal Benjamin Franklin first taught us that sand-banks are sooner recognised by the thermometer than by the sounding line. They are islands of the submarine land, which the elastic subterranean powers had not been able to elevate above the surface of the water. On the declivity of the shoals, the inferior and colder strata ascending by impulse, are mixed with the upper and warmer ones; and thus the sudden cold of the sea-water shews to the navigator that danger is near. The shallows, by their temperature, act on the air above them, in which they produce fogs and groups of clouds, which are perceived at a great distance.

Before more extensive investigations had been made on the distribution of heat over the globe, it was believed that the climate of two places could be determined by the extremes of the temperature in summer and winter. This view of things has still been preserved in popular opinion, whilst naturalists have long ago renounced it as erroneous; for, although undoubtedly the extremes of single days and nights are in a certain propor-

tion to the mean temperature of the year, yet the distribution of heat in the different seasons is strikingly different, although the mean annual temperature be one and the same,—a circumstance which has a very great influence on the growth of plants and on the health of man. I have endeavoured to determine the law of this distribution, according to different situations and heights. But comparative results in numbers ought to contain the mean temperature of every month, derived from the two extremes of every day, supposing an arithmetical series to be formed. This method was first adopted by Reaumur in 1735: he compared the produce of two harvests, not (like Herschel) with the numbers and size of the spots in the sun, but with the quantity of heat which the corn received in the time of vegetation. Many labours have of late been directed towards ascertaining the hour, the mean temperature of which expresses also that of the whole year. I here only mention the observations carried on in Scotland at Leith Fort. The night watch of a military post has been employed for establishing observations of the thermometer during two years, from hour to hour; and from the mass of these observations, which ought to be repeated in other latitudes, it has been calculated, that, in the latitude of Edinburgh, a single daily observation at 9 o'clock 13 minutes in the morning, and in the evening at 8 o'clock 29 minutes, would be sufficient to fix the average heat of the year *. Of the months, it is April and October which give this important result (a fact, first discovered by Leopold and Von Buch, which is connected with remarkable modifications of the upper currents of the atmosphere), except when, as in the island of Grand Canary, local causes carry the maximum of heat to a later period, and place it in October.

If I frequently allude to the great increase of meteorological observations within the last twenty years, I by no means wish to express an opinion that the perfection of climatology is particularly founded on such an increase. Here, as in all collections of knowledge derived from experiments, which are too soon denominated sciences, every thing depends on "an accu-

* A result, which does not differ from the true by one-half degree of Reaumur's thermometer, is also obtained by the mean of two hours of the same denomination.—*Results of the Thermometrical Observations made at Leith Fort every hour of the day and night during the years* 1824 *and* 1825, p. 19.

rate conception of nature," and a just view of the consequences to be drawn from well-arranged facts. If we attempt to conceive the problem of the distribution of temperature in its most general sense, we may imagine the planetary heat either (as in the present oxydised, hardened surface of the earth) to be a consequence of the position in relation to a central body, which excites heat; or (as in the first state of the condensation of matter dissolved in the form of vapour) the consequence of internal processes of oxidation, precipitation, change of capacity, or electro-magnetic currents. Many geognostical phenomena, which I have mentioned in another paper, seem to indicate such a developement of internal heat, produced by our planet itself. Moreover, the doubts raised against the peculiar heat in mines in both parts of the world, have been entirely removed by recent experiments of an ingenious astronomer M. Arago, on water rising up through deep borings in what are called Artesian Wells. The greater the depth from which the water ascends, the warmer it has been found. In this case, there can be no suspicion of strata of air sinking down and being condensed, and consequently disengaging heat; nor can the neighbourhood of men, or of the lanterns of miners, exercise an influence in this case. The waters carry along with them the heat which they have acquired by a long continued contact with rocky masses at different depths.

These important observations shew how, independently of the obliquity of the ecliptic in the earliest, and, as it were, youthful state of our planet, the tropical temperature and tropical vegetation could arise under every zone, and continue, till, by the radiation of heat from the hardened surface of the earth, and by the gradual filling up of the veins with heterogeneous minerals a state was formed, in which (as Fourier has shewn in a profound mathematical work) the heat of the surface, and of the atmosphere, depends merely upon the position of the planet towards a central body, the sun. We gladly resign to other natural philosophers the task to decide, how deep below the oxidised and hardened surface of the earth the melted fluid masses lie, which are poured out through the apertures of volcanoes, which periodically agitate the continents and the bottom of the ocean, and force hot mineral springs upwards through clefts in granite and porphyry. The depth of our mines is too inconsi-

derable to enable us, from the unequal increase of temperature which has been hitherto observed in them, to give the satisfactory numerical solution of a problem which occupies the curiosity of men who live, as it were, upon a vault of rocks. Suffice it here to point out how the recent views of geologists have revived the old mythus of Pyroplegeton and of Hephastos.

When a planet is everywhere surrounded by aërial strata, and when the oxidised surface of the earth, with its clefts almost everywhere closed or filled up, by a long radiation of heat, has arrived at a state of equilibrium between receiving and losing, in such a manner that its external temperature and the difference of climates arise solely from its position towards the sun, towards a larger central body which is perpetually generating light, then the problem of the temperature of any place in its most general form, may be considered as dependent solely upon the manner in which the influence of the meridian height of the sun manifests itself. This height determines, at the same time, the magnitude of the semidiurnal circles, the density of the aërial strata, through which the rays of the sun pass, before they arrive at the horizon; it also determines the quantity of the absorbed or calorific rays (a quantity which rapidly increases with the size of the angle of incidence); and, lastly, the number of the rays of the sun, which, mathematically considered, a given horizon receives. The production of heat, as far as a greater or less is concerned, can accordingly be considered as proceeding from the illuminated surface of the earth. The absorption which the rays of the sun undergo in their passage through the atmosphere, or (to express it in another manner) the production of heat by the diminution of light is extremely small; but nevertheless is perceptible on the ocean, where, at a great distance from the coast, and even when the water was colder than the atmosphere, I observed the temperature of the latter increasing at noon with the height of the sun *.

Recent researches † have shewn, that, in both continents,

* Mr Arago has first called my attention to this remarkable effect of the absorption of light in the atmosphere.—Con. des Tems pour 1828, p. 225.

† Essai Politique sur l'Isle de Cuba, 1826, t. ii. p. 79–92. where I think I have obviated the doubts raised by Mr Atkinson.—Mem. of the Astron. Soc. vol. ii. p. 137, 137.

under the equator, where the mean temperature rises to 82° Fahr. (22°.2 R.) it is not much warmer than it is in 10° north and south latitude. According to the Commentary of Geminus on the Astronomical Poem of Aratus *, some Greek philosophers believed the temperature of the tropics even to surpass that of the equator. M. Arago has, in a very ingenious manner, demonstrated, by numerous optical experiments, that, from the vertical incidence to a zenith distance of 20°, the quantity of the reflected light (and the lesser heating of the illuminated body depends on this quantity), remains almost the same. In comparing the mean annual temperatures with one another, I find, that, in the western part of the old continent, the temperatures diminish from the south towards the north in the following proportion †:

From 20°	to 30° north Latitude.	3°.2	Reaum.
30	40	3 .6	
40	50	5 .7	
50	60	4 .4	

In both the continents, the region where the diminution of heat is most rapid, is to be found between 40° and 45° latitude. In this result, the observation agrees in a remarkable manner with the theory; for the variation of the square of the cosines which expresses the law of the mean temperature, is largest at 45° latitude. This circumstance, as I have shown in another place, has exercised a very beneficial influence on the state of civilisation of those nations who live in the mild countries, under this, the medium parallel of latitude. There the district where the vine grows, borders upon that of the olive and orange tree. Nowhere else upon earth (in proceeding from the north to the south) does the heat increase more rapidly with the geographical latitude; nowhere else do the various vegetable productions, used in gardening and in agriculture, succeed each other more

* Esig. in Aratum eays. 13. Strabo, Geogr. lib. ii. p. 97.

† In the eastern parts of the new continent, the diminutions of the mean temperature are as follows :

From 20°	to 30° Latitude,	5°	Reaum.
30	40	5 .7	
40	50	7 .2	
50	60	5 .8	

rapidly. This variety animates industry and the commercial intercourse of nations.

We may here state that partial, daily, and monthly changes of temperature are, on account of the motion of the atmosphere, produced by the transportation of colder or warmer strata, by greater or less electric tension, by the formation of clouds or the diffusion of vapours; in short, by an almost infinite number of variable causes, acting at a greater or smaller distance. The study of meteorology has, unfortunately, begun in a zone where the causes are most complicated, and the number and intensity of the disturbing powers greatest. If ever civilization, as may now be expected, shall establish one of its principal seats in the tropics, it is to be presumed that these phenomena, which are so simple there, will be more easily ascertained than in our climates, where the play of many conflicting causes has so long concealed them from our view. From that which is simple it is easy to proceed to what is complicated, and we may imagine a scientific meteorology as returning from the tropics to the north. In the climate of palms, a feeble east wind always brings strata of air along with it, having generally the same temperature. The barometer shows, like the progress of the needle, the hour of the day. Earthquakes, tempests, and thunder-storms do not disturb the small but periodical tides of the atmosphere. The changed declination of the sun, together with the upper currents of the air, from the equator towards the pole, modified by this declination, determine the beginning of the rainy season and the electric explosions, which both begin at regular periods. The traveller may know his way almost as well by the direction of the clouds as by the compass; and, in the dry season, the appearance of a cloud on the deep blue sky would, in many districts of the tropics, astonish the natives as much as the fall of an aërolite or of the red polar snow would do us; or as the crash of thunder in Peru; or, in the tropical plains, a hail storm. This simplicity and regularity in the meteorological phenomena allow us to expect an easier and more favourable insight into the relation of their causes.

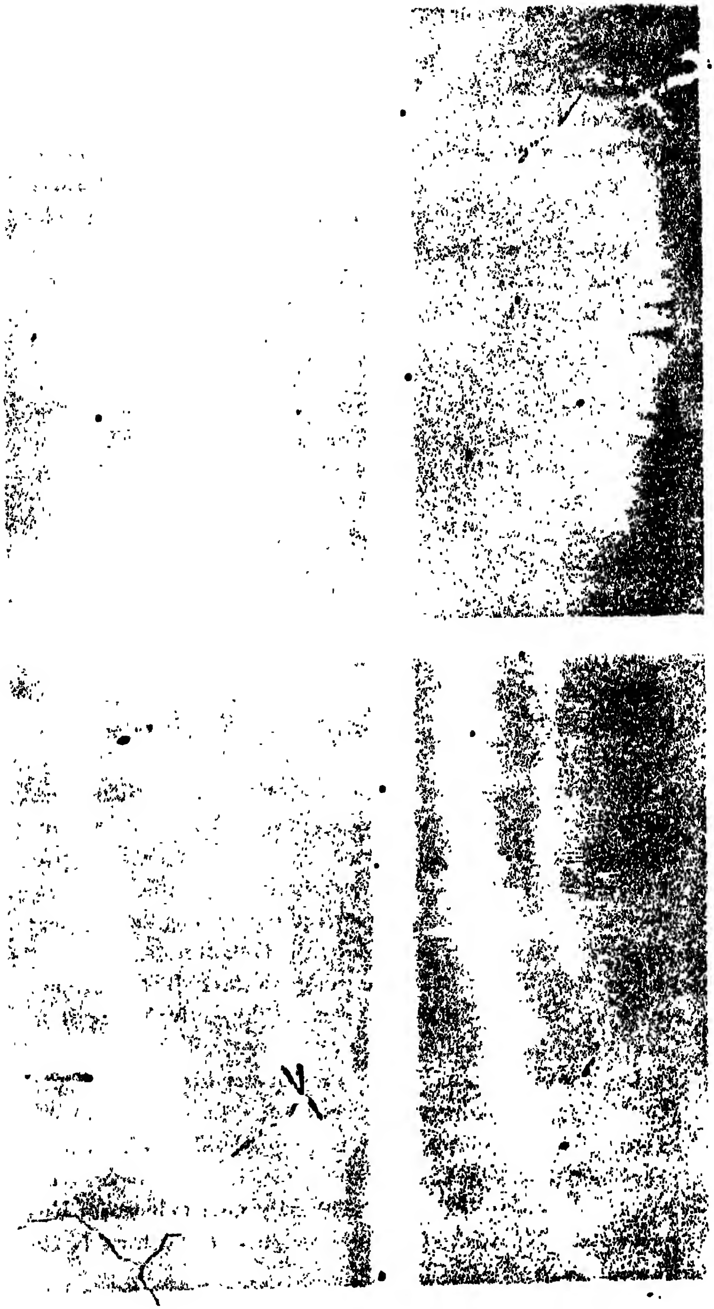
As long as the observations on the magnetic inclination, declination and intensity of forces, remained dispersed in the reports of travellers, and had not been united by magnetical lines,

the doctrine of the distribution of magnetism on the earth could not be expected to make any important progress. Supported by analogy, it has been attempted to simplify by a careful employment of well ascertained facts, the complicated doctrine of the distribution of heat. Places having an equal mean temperature of the year, of summer, or of winter, have been connected with one another by curves. This was the origin of the system of isothermal lines*, of which I published a full account in the year 1817. They descend towards the equator, because in Eastern Asia and the eastern parts of North America we find, on an equal level above the sea, and in a more southern latitude, the same temperature which we meet with in the centre of Europe, in a more northern latitude. The remarkable circumstance, that the highest civilization of the species to which we belong has developed itself, almost under the same latitudes in the temperate zone upon two opposite coasts, the eastern coast of the new and the western of the old continent, must early call our attention to the difference of heat under the same latitudes. The question arose by how many thermometrical degrees the old world was warmer than the new, and it is not long since it was known, that the isothermal lines from the latitude of Florida to that of Labrador, do not run parallel, and that the eastern and western coasts of North America are almost as different from one another as those of Western Europe and of Eastern Asia. The shape and grouping of the continents, and their relation to the neighbouring seas, are the principal causes which determine the inflection of the isothermal lines, or the direction of equally warm zones, into which we may conceive the whole globe to be divided. The predominance of west winds in the temperate and cold regions determines the difference of climates on the eastern and western coasts of one and the same continent. The western winds, which are considered as reactions of the tropical trade-winds reach an eastern coast, after having traversed in winter a continent covered with snow and ice; to the western coasts, on the contrary (in Europe as well as in New California and

* De la Distribution de la Chaleur sur le Globe.—Mem. de la Société d'Arcueil, t. iii.

Nootka), western winds carry strata of air, which even in the severest winter have been heated by contact with the vast surface of the ocean. Led by these ideas, I have considered it of importance to obtain a knowledge of the lowest temperature to which the Atlantic sinks, out of the Gulf Stream, between 40° and 50° north latitude (consequently in the latitudes of Spain, France and Germany). I have found that, in the month of January, in 40° latitude, the water of the sea does not sink below 56° Fahr. (10°.7 R.) and in 45° latitude not below 54° Fahr. (9°.8 R.) The much esteemed geographer of India, Major Rennel, who for thirty years has been employed in studying the direction of the currents of the Atlantic, and who, during my last visit to England, communicated to me a part of his manuscript materials, has, in 50° latitude, consequently in the zone of the north of Germany, observed in winter a temperature of the sea-water, to which the atmosphere does not reach in the month of January, even in the mild climate of Marseilles. If the relative extent of Asia and North America, of the Pacific and the Northern Atlantic, was different from what it is, the whole system of winds in the northern hemisphere, would, by the unequal heating of the solid, as well as of the fluid, parts of the surface of the earth, be changed in their direction as well as in their intensity.

Europe is indebted for its milder climate to its position on the globe (the position in which it stands in regard to the neighbouring seas) and to its peculiar form. Europe is the western part of the old continent; and consequently the great Atlantic Ocean, which already in itself has the power of diminishing the cold, and which is besides partly warmed by the Gulf Stream, lies to the west of it. That part of the world which of all others enjoys the greatest share of a tropical climate, the sandy Africa, is so situate that Europe is heated by the strata of air, which, ascending from Africa, move from the Equator towards the North Pole. Had the Mediterranean not existed, the influence of Africa on the temperature and the geographical distribution of plants and animals in Europe, would have been still more considerable. The third principal cause of the milder climate of Europe is that this part of the world does not approach the North



Pole nearly as much as America and Asia do; and that, on the contrary, it lies opposite the greatest extent of sea-water, free from ice, which is known in the whole polar zone. The coldest points of the earth, which have lately been improperly called Poles of Cold, do not coincide with the magnetic poles, as Dr Brewster has endeavoured to prove in the English version of my paper on the Isothermal Lines. According to Captain Sabine's researches, the minimum of the annual mean temperature on the surface of the earth, is to the NW. of Melville's Island, in the meridian of Behring's Straits, probably in 82° to 83° north Lat. The summer boundary of the ice, which, between Spitzbergen and East Greenland, recedes to 80° and 81° north Lat., is in about 75° N. Lat., every where between Nova Zembla, the Bone Islands of New Siberia and Icey Cape, the most western cape of America. Even the winter boundary of ice, the line on which the ice approaches the nearest to our continent, scarcely surrounds Bear Island. From the North Cape, which is heated by a south-western current of the sea, the navigation to the most southern promontory of Spitzbergen is never interrupted, not even in the most severe winters. The polar ice diminishes in quantity wherever it finds an opening to flow out, as in Baffin's Bay, and between Iceland and Spitzbergen. The situation of the Atlantic Ocean exerts a most beneficial influence on the existence of that sea-water, free from ice, in the meridian of East Greenland and Spitzbergen, which has so important an influence upon the climate of the north of Europe.

On the other hand, the icebergs, which are driven from Baffin's Bay and Barrow's Straits to the south, accumulate in that large *mediterranean* sea, which geographers designate by the name of Hudson's Bay. This accumulation of ice increases the cold of the neighbouring continent so much, that, as reported by Captain Franklin in his latest MS., in York Factory, and at the mouth of Hayes River, which lie in the same latitudes as the north of Prussia and Courland, in digging wells, ice is found everywhere at the depth of four feet. The most northern and most southern boundaries of the fixed polar ice, that is, the summer and winter boundaries, on the situation of which the temperature of the northern continents depends, seem to have changed but little, as far as historical records go; which fact

has been recently confirmed by careful inquiries. The injurious influence which small isolated masses of ice, driven sometimes by currents into the neighbourhood of the Azores, exercise, as it is said, upon the continent of Europe, is one of those tales, first derived from philosophers, and received by the vulgar, after the former have long ceased to believe in them.

In the same latitudes, where, in the north of Europe, agriculture and gardening are carried on, we find in North America and North Asia only marshes and tracts of land covered with mosses: in the interior of Asia, on the other hand, the powerful radiation of heat, between the almost parallel chains of the Himalaya, the *Zungling* and the *Himmelsgebirge*, (a country on which Klaproth's geographical researches have thrown great light), exercises the most beneficial influence on the Asiatic population. The line of permanent snow, on the northern declivity of the Himalaya, lies 4000 feet higher than on the southern; and the physical explanation which I have given of this singular phenomenon *, has, according to a report of Mr Colebrooke, been confirmed by recent measurements and observations in the East Indies. Millions of men of Thibetian origin, of a gloomy religious cast of mind, occupy populous towns, in a country where fields and towns would, during the whole year, be buried in deep snow, if this high table-land was less extensive and less continuous.

As the currents of the atmosphere are modified in many different manners, by changes in the declination of the sun, and by the direction of the chains of mountains on the declivities of which they descend, the currents, also, of the liquid ocean carry the warmer waters of the lower degrees of latitude into the temperate zone. I need not here mention how the waters of the Atlantic, always moved in the same direction by the trade-winds, are carried against the dike formed by the isthmus of Nicaragua, then turn to the north, make the round of the Gulf of Mexico, flow out through the Channel of the Bahamas, proceed as a current of warm water to the north-east towards the banks of Newfoundland, then to the south-east, towards the group of the Azores; and, when favoured by the north-west

* Annales de Chimie et de Physique, tom. iii. p. 297; tom. ix. p. 310; tom. xiv. p. 5.

wind, carry along with them the fruits of palm trees from the Antilles; casks of French wines from wrecked ships; nay, even living Esquimaux in their leather boats from East Greenland, which they cast on the coasts of Ireland, of the Hebrides, or of Norway. A travelled astronomer, Captain Sabine, who, after returning from the Polar Regions, performed experiments with the pendulum in the Gulf of Guinea, on the African Island of St Thomas, informed me, how casks of palm oil, which had been lost by shipwreck at Cape Lopez, a little south of the Equator, were carried onwards, first by the equatorial current, and then by the Gulf Stream, crossing the Atlantic twice, from east to west, and from west to east, between 3° and 50° N. Lat., safely arrived on the coasts of Scotland. The well preserved mark of the African proprietors left no doubt as to the direction the casks had taken. In the same manner, as in this case, the equatorial waters in the Atlantic are carried north by the Gulf Stream, I have, in the Pacific, in its southern hemisphere, observed a current (along the coasts of Chili and Peru), which carries colder water from higher latitudes to the Tropics. In this current I saw the thermometer, in the port of Truxillo, in the month of September, fall to 61° Fahr. (12°.8 R.) and in the port of Callao, near Lima, at the end of November, to 60° Fahr. (12°.4 R.) A distinguished young officer of the Danish navy, Baron Direkinck von Holmfeldt, has, at my request, at different seasons of the year 1825, observed this singular phenomenon, to which for so long a time no attention had been paid. Making use of thermometers, carefully compared by Mr Gay Lussac and myself, he again found the water of the sea, in the port of Callao, in August 60½° Fahr. (12°.6 R.) and in March 67½° Fahr. (15°.7 R.) Whilst, out of the current, at the promontory of Parina, the calm sea, as usually in those latitudes, showed the great heat of 79½° to 81°.5 (21° to 22° R.) We cannot, in this place, explain how this stream of colder water, which increases the difficulty of the southern navigation from Guayaquil to Peru, and from Peru to Chili, is for some months modified in its temperature by the Garua, *i. e.* the vapours which constantly veil the sun; and how it renders the climate of the plains of Peru cooler.

As all human attempts to arrive at a scientific view of the

phenomena of nature can have for their final object only a clear conception of our own nature, thus the investigation, with the principal topics of which we have now been occupied, at last leads us to consider, how the differences of climate manifest themselves in the character, in the civilization, and, perhaps, even in the development of the language of different tribes of the human race. This is the point where the important doctrine of the distribution of heat over the globe comes to be connected with the history of mankind, and beyond which it ceases to be an object of purely physical inquiry.

Some Account of the Habits of a Specimen of Siren lacertina, *which has been kept alive at Canonmills, near Edinburgh, for more than two years past.* By PATRICK NEILL, A. M., F. R. S. E. and Sec. W. S *. Communicated by the Author.

IT is more than half a century since Dr Alexander Garden of Charleston, South Carolina, sent to the distinguished Mr John Ellis of London, specimens of a reptile found in marshes in his neighbourhood, remarkable for possessing both external gills and internal lungs, and for having fore-feet but no hind-feet. Dr Garden stated, that he had seen specimens of very different sizes, all possessing the gills, and having only fore feet; and that there did not exist in South Carolina any lizard, of which this animal could be regarded as the larva. Mr Ellis, in his excellent account of the reptile in the Philosophical Transactions, vol. lvi., accordingly describes and figures a young one, 9 inches long, and one full grown, or $2\frac{1}{3}$ feet long; yet both possess the gills, and both have two feet only; the feet have four toes, and each toe is furnished with a claw; and he mentions that the animal emits a "croaking noise or sound," while the possessing of any kind of voice is not characteristic of a larva. These facts, and the examination of a dead specimen, transmitted by Mr Ellis to the illustrious Swedish naturalist Linnæus, were enough to satisfy him that it was not a larva, but a perfect animal of the most truly amphibious character; and he therefore created for it a new order, *Meantes*, among his Amphibia. Several distin-

* Read before the Wernerian Natural History Society, 12th January 1828

guished naturalists, however, have disputed the opinions of Garden, Ellis, and Linnæus; particularly Camper, Pallas, Schneider, and De Lacepede. All of these have held, that the siren is not a perfect animal, but merely the larva of some Proteus or Lacerta, which, as it should approach maturity, would throw off the branchiæ, and perhaps also develope hind-feet. De Lacepede was the most positive in this opinion; but he was soon met by another French naturalist, of greater acumen and of still higher name.

In a memoir read to the Institute of France in 1807, Baron G. Cuvier concluded, from a minute *anatomical* examination, that the siren was the type of a distinct genus, the osseous structure of which differed essentially from that of the salamander or of the proteus; the skeleton proving that the animal was not destined ever to develope hind-feet, while there appeared no provision for the throwing off of the branchiæ. Cuvier confirmed, in short, the opinion which Linnæus had formed from studying its external characters and from Dr Garden's account of the habits of the animal.

The controversy has been continued with zeal and spirit. The distinguished Italian naturalists Configliachi and Rusconi, from considering the analogy between the Siren and the larvæ of other Batrachia, have disputed the conclusions of Cuvier, and still regard it as an imperfect animal. Among other arguments, they adduce the following, which shall be quoted in their own words: "Before this canal (the nostril) is so formed (as to open into the mouth), such larvæ are unable to respire atmospheric air, and if taken out of the water they soon die; and, therefore, guided by analogy, we incline to believe that to the siren the same thing ought to happen *."

That excellent zoologist our countryman Dr Fleming of Flisk

* See account of Configliachi and Rusconi's Memoir, by Daniel Ellis, Esq., in the Edinburgh Philosophical Journal, vol. v. p. 105. *et seq.* The original passage runs thus: "Sin tanto che questo canale non si è formato" (in such a manner that its posterior extremity may open into the mouth), "le larve delle salamandre non possono respirare l'aria atmosferica in modo alcuno, e quindi se vengono tratte all' asciutto, si muojono; per lo che noi, guidati sempre dalla analogia, incliniamo a credere che alla sirena, le cui narici "ne penetrent point dans la bouche," debba pure accadere lo stesso."—*Del Proteo anguino di Laurenti Monografia*: Pavia, 1819, p. 101.

(whose fame will be greatly raised by his recent work on "British Animals") adopts the reasoning of the Italian naturalists, and vindicates their conclusions, in his "Philosophy of Zoology," vol. ii. p. 297.

It is remarkable that some parts of the natural history of the siren should still be very imperfectly known, not only to eminent European naturalists, but even to acute observers residing in the United States. We have seen that Configliachi and Rusconi are of opinion that the siren, if taken out of the water, would soon die; and we may add, that the author of the article Herpetology in the Edinburgh Encyclopædia observes, that the Siren lacertina "appears to reside entirely in the water. It was supposed by Linnæus, from the form of its feet, that it can also move with tolerable ease upon the land; but we believe it has never yet been seen in that situation."

In a paper on the genera of batrachian animals, by Mr Barnes, secretary of the New York Lyceum (published in Silliman's American Journal, October 1826), we have the most recent notice regarding the siren. After describing the animal, he mentions some facts illustrative of its habits, and alludes to some of the opinions entertained concerning it. We are told, that "a specimen in Scudder's Museum (New York) has already lived several years in a glass jar of clear water," and others an equal length of time "in a tub containing mud brought from their native marshes in Carolina." These, "when taken from the mud, immediately struggle to return, and seem contented only when they are in their natural element. When they are concealed in their retreat, the place of the head and gills is readily known by the rising of small air-bubbles from their spiracles;—a fact which may lead to the determination of the function of these doubtful organs." "Several authors affirm that sirens thrown on the ground break into several pieces." While Mr Barnes hesitates to believe this, he adds,—"But the want, or the high value of specimens among us *,

* The siren, though not uncommon in the days of Garden, seems now to have become a rare animal even in South Carolina. M. Bosc, in the New Dictionary of Natural History (xxxi. p. 317), mentions that, during a residence of a year and a-half near Charleston, he was not able to find one living specimen, although he was desirous of studying the habits of so curious an animal.

will probably prevent this fact from being proved or disproved by actual experiment." Lastly, it is said, "It does not appear, by the most careful observations of modern naturalists, that the animal has a *vox cantillans*, and the idea which produced the generic name is therefore imaginary."

In the early part of the summer of 1825, Dr Farmer of Charleston, South Carolina, sent to Dr Monro, Professor of Anatomy and Surgery in the University of Edinburgh, a living specimen of the animal. It was nearly a foot and a half long, and was four inches in girth where thickest. It came in a small barrel, which was half filled with mud and water, and perforated above. On its arrival in this country it seemed in a sluggish state; and it was not observed to eat any thing whatever for many weeks. Dr Monro being desirous that the animal should, if possible, be preserved alive, and its habits noted, confided the charge of it to me; and I certainly feel much indebted to the Doctor for placing so rare and curious an animal in my hands. Although, during the two years and a-half it has been in my possession, no perceptible change has taken place in the form or size of the fimbriated branchiæ, and although I cannot boast of having made any new or very striking observations, yet perhaps I am able to add a little to our stock of knowledge regarding this singular animal, and to confirm some and refute others of the opinions above related.

Immediately on receiving the specimen, a large wooden box was prepared, with an inclined plane at one end of the interior, so that the animal might, when it chose, raise itself out of the water more or less, and repose in that situation. At first we placed a quantity of sand in the bottom of the box, in the expectation that the siren would burrow in it; but we afterwards found that tufts of mosses (hypnum or sphagnum) were better suited to the taste and habits of the animal, as it evidently delighted to hide itself under the moss, to lie upon it, and to root amongst it.

Soon after it came into my possession I found that, in a warm day, it would eat one or two small earth-worms, when placed close by its head, so that the struggles of the worm, in drowning, should attract its attention (for its eyesight does not seem acute); but that it would take no more food till after the lapse of per-

haps a week or ten days. At this time it swallowed its food very slowly and gradually, sometimes allowing one-half of the worm to continue wriggling about its nose for some minutes, while the other half was in its mouth and gullet. On one occasion, some small banstickles were put into the box alive: after a day or two, the largest of these was found floating dead, with a considerable piece apparently bitten from its side, the wound being nearly equal to the width of the siren's jaws. Although the siren was not actually observed to attack the banstickle, there can be little doubt that he had seized it, and taken the piece from its side; more especially since Dr Garden mentions that, on one occasion, a siren was "caught by a hook baited with a small fish." The smaller banstickles were never more seen; and two or three of the larvæ of the *Lacerta aquatica*, which were placed in the box soon afterwards, likewise disappeared.

For the first year and a half, the box was kept in a green-house, adapted for keeping Cape of Good Hope and New Holland plants, or where it is merely desired to exclude the frost of our winter. In this situation, the siren declined eating from about the middle of October till the beginning of May; and for the six intervening cold months he remained exceedingly sluggish, seldom changing his place, except when roughly touched.

It may here be remarked, that the tail seems to be the most sensitive part of this animal. I have often gently stroked the back, near the head, with my fingers, without disturbing him in the least; but the moment the tail was touched, some air-bubbles were thrown up, and he moved slowly away.

In April 1827, the box was placed in a hot-house, intended for the culture of tropical plants, where the temperature is kept up so as to range from 60° to 80° F., and may be stated as generally about 65°. Here the animal became more lively. He soon began to croak like a frog, uttering a single cry at a time, and without any change of note. He continued thus to call for some weeks; and, considering the time of the year, it seems probable that this was the call of love. During this summer he ate two, three, or even four, small earth-worms at a meal, devouring them much more quickly than formerly. It was now observed, that after the siren got his eye on the worm, he approached very cautiously, remained motionless for a moment, as if

watching, and then made a sudden dart upon the prey. Still, however, he did not care for food oftener than once in a week or ten days. When touched, he now changed his place with a jerking motion, causing the water to spurt.

Although I certainly would not have made the experiment of the fragility of the siren, by throwing it on the ground; and although I would have hesitated to keep the animal out of the water for several hours, while I knew that respectable naturalists doubted if it would live more than a few minutes out of that element, yet it so happened, that the animal, on one occasion, made, of his own accord, an experiment (if it may be so called) illustrative of both points. This was on the 13th of May 1826 (for the fact was recorded in my *adversaria* at the time), soon after he had begun to be active and to take food for the season. The water-box itself was ten inches deep: it was placed on a plant-trellis or shelf, close by the lower end of the sloping roof-sash of the greenhouse, and thus stood nearly three feet from the ground. At that period the box happened to leak; and the gardener therefore filled it up with water between seven and eight o'clock in the evening, at which time the siren was seen safely lodged in the box. The door of the greenhouse was locked, as usual, over night, and before it was opened in the morning, the siren, to the great surprise of the gardener, was found lying on a foot-path which passes round the exterior of the greenhouse. I was speedily apprised of the circumstance; and, on examining the spot, we could most distinctly trace, by a shining glaze derived from his skin, the passage of the animal through an edging of heath (*Erica herbacea*), and across a narrow flower-border, to a hole which he had scooped out under the brick-wall of the greenhouse, in escaping from within. The foundation of this wall, it may be remarked, had intentionally been made shallow or near to the surface, for the purpose of permitting the roots of some shrubs, planted in the conservatory style within, to penetrate to the exterior border.

We possess no data for fixing with certainty the number of hours during which the animal had been out of the water. The box, as already mentioned, being leaky, was filled near to the brim between 7 and 8 in the evening: it seems likely that this filling up had disturbed the animal, and that it had been enabled partly to crawl and partly to glide over the margin, while

the water yet stood high, or early in the night; for the water had subsided five or six inches before morning. The escape of so much water, had formed, of the soil below, a kind of sludge, probably somewhat analogous in character to the "stiff clay" of its native swamps, in which it is said sometimes to burrow; and this must have greatly facilitated the first under-ground operations of the siren. Still, however, as the excavation made was not less than eight inches in depth, and nearly three feet in length, for the ascending aperture on the outside sloped at an angle of about 30°, it seems reasonable to conclude that the siren must have been several hours hard at work in forming so extensive a tunnel for itself. In farther proof of its exertions, it may be observed, that a considerable part of the dark-coloured epidermis, or covering of minute indistinct scales, was worn off its snout, and the skin of the upper part of the back was, in different places, ruffled.—In passing, it may be noticed, that these facts indicate that its progress had depended more on rooting with the nose and shoving with the shoulders, than on digging or scraping with the feet and toes, the claws or nails of which are indeed rather of a delicate texture.

Mr Barnes was evidently right, therefore, in considering the fragility of the siren as "improbable;" for, far from being broken in pieces, by its fall of more than three feet and a-half from the upper margin of the box, it is abundantly evident that the animal had suffered nothing from this fall, else it would not immediately afterwards have made such progress in mining. In justice to Dr Garden, however, who was evidently an accurate observer, it should be mentioned, that he does not allege that the siren, if merely "thrown on the ground," will break in pieces; but only states that, on one occasion, a specimen did so when "*dashed forcibly* against the ground," by his servant, with the view of killing it.

The morning was very cold, and the mercury in a register-thermometer, kept in the greenhouse, had been as low as 33° Fahr. at one period of the preceding night. The animal was observed about 7 A. M. lying doubled, or with the body bent round, but not coiled, on the foot-path. He was exceedingly benumbed, being just able to shew signs of life when lifted by the gardener. Considering the evidence of long-continued active exertions during the night, it seems reasonable to ascribe

his almost torpid state when found, to the freezing cold which he had encountered when he had made his way fairly to the outside. When first restored to the watery element, the animal breathed hard, rushing to the surface, and opening his mouth with a wide gape to inhale air. He soon after sunk down, and let several strings of air-bubbles escape. The branchiæ were doubtless to a certain degree dried, and thus obstructed; and it evidently took some time before they could freely perform their accustomed office. When, however, I again examined the animal, several hours afterwards, he seemed perfectly contented to remain wholly under the water; and, on being touched, appeared as lively and as well as ever. The decorticated portions of the back and snout shewed us the colour of the true skin below, which was of a pale leaden hue.

In the course of changing the water and moss, we have occasionally placed the siren on the floor of the hot-house, or on the dry ground. He certainly did not on these occasions seem adept at progressive motion: but, on the contrary, tumbled about rather awkwardly. From the exertions he made, however, we were inclined to think, that among wet grass he might probably get on pretty well; for he exhibited no indications of pain or uneasiness, but merely a desire to escape or get under cover.

We have often remarked this fact, that, if the animal be left in undisturbed tranquillity, he will lie at the bottom of the deepest part of the box, where the water is generally six inches deep, for hours together, without coming to the surface, and without discharging air-bubbles: but on these occasions, on looking attentively into the water, as I have done for twenty minutes at a time, a slight current may be observed to be excited behind the gills, about twice in a minute. The current is sometimes so gentle, that it is only to be observed by noticing the motion of minute particles of decayed moss which come within its influence. The moment his tail is touched, the animal exerts himself; air-bubbles escape, and he soon after comes to the surface to take in air by the mouth. When the box is to be cleaned out, which is done about once a fortnight, the siren is placed in an oval jar among water; here he moves about with rapidity, and very frequently projects his nose and mouth above the surface, evidently to inhale air.

The animal has, since it came into my possession, decidedly increased in volume, particularly in thickness or plumpness; but I am not, as already noticed, aware of the least change having taken place in the appearance of the fimbriated branchiæ, where a change should first be looked for were the animal a larva.

The scars of the injuries which he received in his subterranean excursion of May 1826, remained visible for a year after the occurrence; but they have now (January 1828) completely disappeared, and the whole body is covered with a dark glossy epidermis, consisting of very minute scales, and marked with small dots of white.

The results of the observations now made seem to be:—That, as Dr Monro's specimen of the Siren lacertina did *not* "soon die when out of the water,"—did *not*, like the Italian proteus, "die as fishes do," when removed from that element,—but, on the contrary, lived many hours out of the water, respiring atmospheric air by means of its lungs; and as it has often been observed to remain for hours under the water without coming to the surface to breathe, Baron Cuvier is right in regarding the siren as a perfect animal, of a truly amphibious character, destined to breathe through life either by means of external branchiæ or of internal pulmonary apparatus, according to the situation it may for the time occupy in its native marshes:—That Mr Barnes was right in doubting the story of its being a fragile animal:—That it has a voice like the croaking of a frog, but not a *vox cantillans*, if this last imply any thing musical; but here it should be remarked, that Mr John Ellis accurately characterizes it as a "croaking noise or sound:"—That, as it attacked a large banstickle, and probably devoured some small ones as well as larvæ of Lacerta aquatica, it may, in its native lakes and swamps, attack small fishes, or even small serpents, as mentioned by some naturalists:—That Configliachi and Rusconi have been misled by trusting to "analogy," and, by an error of Dr Pockels, who mistook the Amphiuma means, which he saw in the Hunterian collection at London, for a perfectly developed siren. These naturalists expressly admit, that they had not themselves enjoyed an opportunity of dissecting a siren (p. 96. Note); and it is also evident from other parts of their monograph, that they had never seen a living specimen.

P. S. Since this paper was read to the Wernerian Society, I have seen, in Silliman's American Journal of Science, September 1827, p. 70. an additional notice regarding the siren by Mr Barnes; in which he says, " Captain Le Conte has dissected a large siren *alive*, and has actually seen the expansion and contraction of the lungs in the act of respiration, just as in the frogs and tortoises. They are *true lungs*, and not merely *air sacks*, and their connection with the heart and the arteries was distinctly observed."

A Tour to the South of France and the Pyrenees in the year 1825. By G. A. Walker Arnott, Esq. F. R. S. E. F. L. S M. W. S. &c. (Continued from last Number, p. 139.)

On the 21st June, having, with much regret, seen our two friends MM. Requien and Audibert set off in the diligence for Perpignan, we ourselves also left Prades, and ascended the Confflent towards Mont Louis. On our route we again passed the Traucade d'Ambouilla, and though we did not find it convenient to leave the road, we nevertheless observed there *Tortula chloronotos*, probably the identical station from whence Bridel procured his specimens when he first described the species; and though small specimens have since been found in Teneriffe, and published by Dr Hooker as *Tortula membranifolia*, and though, as I think I have already mentioned, I have found it not uncommon in the olive district of the south of France *, this locality was yet very interesting. In its neighbourhood also, we saw *Buffonia perennis*, *Galium glaucum*, and *Alyssum halimifolium*, all of which, however, we had observed on other parts of the Traucade a few days before. Passing through Villefranche, we saw in profusion *Sarcocapnos enneaphylla*, an elegant plant, closely allied to *Fumaria*: this occurs both on the church walls and on the walls of the town, outside of the south gate. We now crossed the Teta, and proceeded up the western

* It has also been found in Switzerland, and is the *T. muralis*, var. *lanuginosa*, of some of the Swiss collectors; and it even exists in Beauvois' herbarium from the neighbourhood of Paris, under the name of *Tortula canescens*, P. B.

bank, without observing any thing worthy of notice, till we approached the village of Serdynia. On the mountain close to this is found the *Onopordum pyrenaicum*; and, soon after quitting the village, we met with the curious *Achillæa chamæmelifolia*, Pourr. growing on the bank on the right. This species Lapeyrouse has unfortunately described three times in his Flora of the Pyrenees: it is his *A. chamæmelifolia*, *A. capillata*, and *A. falcata*. This latter state of it has the segments of the leaves more or less curved backwards, and has been sometimes given to botanists by Lapeyrouse himself with the name of *A. recurvifolia* attached. From Serdynia to Olette, where we breakfasted, we did not observe any other plant that interested us.

I have already alluded to the tremendous storms that had occurred every day for some time past. Although the mornings were unclouded, and the sun shone forth in full power, the sky began to darken about two o'clock, and thunder, lightning, and rain raged with the utmost fury for about two or three hours, after which we usually had delightful evenings. Accustomed to judge of the violence of the storms according to the extent of our exposure to them, we, having been the greater part of the day in the house, had allowed that of yesterday to pass almost unheeded. To-day, however, about Olette we were led to understand that its violence had been much greater, and of longer duration, than those of any of the previous days. The effects indeed were tremendous. Huge masses of stone had been brought down from the hills by the torrents of rain, and now lay scattered along the road: the upper soil of the vineyards had been completely washed away, while the vines themselves lay scattered in every direction. The peasantry already saw the hopes of a harvest blasted.

Leaving Olette, the road again crosses the Teta, and the ascent becomes very steep, until we arrive at the Graux d'Olette, a romantic spot, where we found *Buffonia perennis*, and the narrow-leaved variety of *Centraullius ruber* (*C. angustifolius* of authors). From this the river begins to present several small but beautiful cascades, and although the road descends a little at the Graux, it soon again begins to ascend rapidly. Passing the village of Thues, we saw *Ligusticum* (*Cnidium* Spr). *pyrenaicum* abundant; and towards Fontledrouse and Cassagne we

observed in the meadows a rough-scaped *Armeria*, that we had previously observed at Bellegarde and La Jonquiere: it is probably *A. plantaginea*, if indeed the whole genus *Armeria* be not reducible to one species.

Although the morning had hitherto been fine, the clouds and mist now began to gather on the hills, and indicated an approaching storm. This induced us to neglect botany, and hurry onwards. About a mile from Mont Louis we again crossed the Teta. At this point there were close to us some considerable water-falls; but the noise of the water was not sufficient to conceal that of the thunder, which at the instant burst upon us in awful grandeur. For a few seconds we attempted to procure shelter under a projecting rock, but immediately deemed it more prudent, being thoroughly wet, to proceed. Whilst there, two bolts must have burst within a few yards of us, so instantaneous were the flash and the peal. We arrived, however, safely at Mont Louis, or rather at the cabanasse or village close to the fortress, where indeed we were to procure accommodation, being more convenient for us than the fort, on account of their shutting the gates, and pulling up the drawbridge, at night. Our horses had arrived a short time before us, without much damage done to either our paper or plants, a circumstance which now interested us more than ourselves.

To-day in our ascent we saw abundance of *Sempervivum arachnoideum* in flower: *S. montanum* also occurred: *Sedum brevissimum*, DC. was observed, but in small quantities. Between the Graux d'Olette and Thues, we found *Cistus laurifolius* in profusion on both sides of the road, and it is not improbable that the few plants of this species we formerly found at Perpignan, may have been carried down there from this station by the stream. *Medicago suffruticosa* has been every where abundant since we entered the mountainous district. I have already stated, that our new species *M. leicarpa* resembles this closely, but differs by the glabrous fruit. I may remark here in addition, that *M. leiocarpa* always grows on the chalky or limestone range, while the other species, *M. suffruticosa*, is found only on the schistose and older formations. We have occasionally observed a few plants of the latter, it is true, down

in the plains, but always in the beds of mountain rivulets, indicating that these were stragglers, and had been carried down by torrents.

On the 23d, being rainy and disagreeable weather, our excursion was short, confining ourselves to the immediate vicinity of the cabanasse. In meadows, however, close to the road that leads to Mont Louis, we met with *Dianthus atrorubens*, *Pedicularis verticillata*, and *Trifolium spadiceum*, all abundant, and in an excellent state for preservation. Near them also was *Vicia onobrychoides*. Descending the road we had come by yesterday for a little way, we then crossed a small stream on the right, and found on a bank beautiful specimens of *Didymodon glaucescens*, *Genista* * *sagittalis* and *purgans*, and *Draba nemoralis*. There

* I take this opportunity of stating, that *Cytisus heterophyllus*, Lap., is, I think, identical with *Genista prostrata*, Lam. and DC. Prod. This plant must not, however, be confounded, as has been done by Willdenow, and even by De Candolle in the Flore Francaise, with *G. decumbens*, W. M. De Candolle, in the Supplement to the Flore Francaise, himself desires this synonym to be excluded; and though he does not cite Willdenow's plant under *G. prostrata* in the Prodromus, 2. p. 152, he leaves it as undetermined, or, in other words, he omits all notice of it. Willdenow, in his description (vol. iii. p. 941), points out how his plant differs from *G. procumbens*, W. K.; and I think there are few who have seen Lamark's *G. prostrata*, that will not immediately recognise it and *G. procumbens*, W. K., and DC. Prod. to be one and the same. The *G. procumbens* of Schleicher is also *G. prostrata*; but *G. decumbens* of the same is *G. pilosa*, Linn. As to *G. decumbens*, W., or *Spartium decumbens*, Ait., it may be distinguished by verbatim the same character that Sprengel applies to *G. prostrata* (v. iii. p. 220.): he adduces, however, *G. decumbens*, W. as a synonym, and his description was probably drawn up with a view to that plant. It will also be easily perceived that Sprengel's *Cytisus procumbens* (iii. p. 224.) is the true *G. prostrata*.

I shall here also notice another mistake that has crept into the Prodromus in the allied genus *Cytisus*. *C. capitatus* is inserted in the Flore Francaise; but in the Supplement, De Candolle points out the error, and states that it is *C. supinus* that has been taken for it; yet it is to the *C. supinus* he alludes in the Prodromus, when he says that it grows in the east of Burgundy, and that its "Flores interdum autumno laterales evadunt." As to the *C. supinus* in the Prodromus, he has both kept it as a good species, and at the same time reduced it to *C. biflorus*. Lastly, his character of *C. supinus*, in the Supplement to the Flore Francaise, p. 549, "la lèvre superieure à 3 dents, l'inferieure à 2 parties," is extremely incorrect. *C. hirsutus*, Schleicher, is *C. supinus*. *C. supinus*, Lapeyr. on the other hand, is the true *C. capitatus*; but what his *C. capitatus* is I am not sure; probably a mixture of *C. capitatus* and *C. supinus*.

was here a thicket of *Lonicera Xylosteum*, and some pretty species of the genus *Rosa*, but of which at present we did not gather any. *Thlaspi alpestre*, *Asperugo procumbens*, and *Apargia pyrenaica*, we observed, but sparingly. There were also here some alpine mosses, as the piliferous variety of *Trichostomum patens*, *Grimmia ovata* *, particularly that state called *Dicranum ovale*, *Orthotrichum rupincola*, *Tortula mucronifolia*, and *Encalypta ciliata*.

"23d June.—The two principal excursions to be made around Mont Louis are to the Vallée d'Eyne, and to the mountain of Cambredazes. The unpleasant weather we experienced yesterday had induced us to postpone our visit to the first of these; but this morning the sun shone forth so clearly, and the sky was so pure, that we almost regretted the relinquishing a plan we had formed even before our departure from Prades; the specimens, however, we had procured during these two last days would be all the better, and certainly nothing the worse, of this delay. We now also, that the hazy weather had left us, began to see somewhat about us. The cabanasse is situated in a large tract of alpine meadows. On the north is a low hill, with the fort of Mont Louis on its summit, and to the south the mountain of Cambredazes, celebrated in the Flora of the Pyrenees. This does not appear of great height; but that may be partly owing to our being at present at a considerable elevation, most probably much more than 4000 feet above the sea: indeed, the plants we had observed, particularly the appearance of the *Rhododendrum ferrugineum* and *Juncus trifidus* (which were found today north of the fort), the coldness of the springs (about 45° Fahr. or scarcely 6° Reaum.) indicate at least that altitude, as well as does the sharpness of the air, which, when we were not exposed to the sun, we felt to be tolerably chill. To the west of us is French Cerdagne, and indeed not a mile from the cabanasse, the rivulets flow into Spain.

"The 24th we undertook the botanical examination of the Vallée d'Eyne, accompanied by a mule loaded with as much provisions as we thought might suffice for three days, with our cloaks, and with two or three reams of paper. The first day

* I do not here allude to *T. funale*, Schw., a very different plant, between which and *Grimmia spiralis* I can find no difference.

was passed in botanising among the banks and rocks that are chiefly to the right of the stream that traverses this rich valley, and in crossing the Col or Cueillade de Norin which terminates it. Descending then the Cueillade towards Catalonia, we arrived in the evening at the hermitage of Nouri, but, unfortunately for us, a day too early. The Curate of Querals, who passes always the summer in this vast building, was not to arrive till the next day; the few beds that were there were locked up, and we found merely four shepherds, whose united stock of furniture consisted of two coarse blankets or rugs, one kettle, one porringer, and two wooden spoons. Finding we were to receive no benefit from these our companions, wrapping our cloaks around us, we stretched ourselves out as well as we could on some long, narrow, and sufficiently hard wooden benches around a large fire, which we found it necessary to keep blazing the whole night *, to prevent our suffering from the piercing cold, for we could scarcely be less, whatever more, than 2000 feet above the level of Mont Louis.

"Notwithstanding our precautions and the fatigues of yesterday, having slept little, we amused ourselves in the morning, until day-light, in observing the culinary proceedings of the poor shepherds, and in listening to the anecdotes they told us of the visit that Mina paid to this place during the last war. It appeared that this general, repulsed and surrounded on all sides by different bodies of the French soldiery, passed here three days, while the snow lay deep on the ground, in making useless attempts to regain the plains below, without encountering his enemies. Having at length consumed all the provisions, seeing his followers fainting with cold and fatigue, and after having burned the doors, window-shutters, tables, chairs, and, in short, every thing that was combustible, in order to warm themselves, he formed the scheme of causing his band to separate, and appointed Sco d'Urgel as a rendezvous. He himself with one party made an attempt to pass by the walls of the town of Puycerda, where the Baron d'Eroles then was with the Spanish

* Throughout the interior of Catalonia, the fire is on the ground, and the chimney (as was formerly to be seen in every farm-house in Scotland, though now of less frequent occurrence), broad at the base, and contracted at the top, arises perpendicularly above the fire.

royalists, and from whence he made no movement to arrest Mina, as is supposed, through jealousy of the French. Such at least is the account that the inhabitants give (and perhaps think it the most plausible) when a stranger asks them what has become of the forty beds and of the furniture, of which this immense pile of building used formerly to boast.

"On the 25th, we descended slowly along the wild and picturesque valley of Querals, and soon encountered the first part of the retinue of the *Senor Rector*, composed of a man armed with a gun, and three others with pick-axes, to repair the path where the winter storms had rendered it impassable for mules. So soon as they perceived us at a distance they made a halt, gazing on us open-mouthed, and whilst we passed them, they could scarcely reply to the customary salutation of "Dios guarda" that we made them. In the evening, indeed, they acknowledged, that, seeing us both dressed in grey from top to toe, armed with our boxes and cartons, holding an open knife in one hand, and a stick shod also with a knife in the other, they took us for some new kind of banditti, and were so completely terrified, that, as the valiant fellow with the musket declared, if he had had the power, he would have thrown away his piece, and taken to his heels.

"About a mile lower down, we met the *rector* himself, with the greater part of his suite, composed of eight or ten men, three young and handsome maid-servants, and seven or eight mules, loaded with provisions and kitchen utensils. The curate, far from corresponding to what one expected from such a retinue, was dirty and disgusting in the extreme, and, like many of his brethren in that country, his ignorance, his want of religion, and his licentiousness, were but feebly concealed by a few superstitious rites.

"Returning in the evening to Nouri, having spread out our plants, we petitioned for a bed for that night; and perceiving that our provisions were nearly exhausted, we asked the curate if he would provide us with supper; but aware that, in Roussillon, the curates are accustomed to welcome a traveller to their table in those districts where there is no inn, it was not without some fear of offence that we hinted that we should pay for what we should have. But he was not so easily affronted,

"S'death, I suppose so," shouted he in his abominable Catalonian tongue, and next morning he presented us with the following account:—One pound and a half of (black) bread, one piécete*; half a pound of *rostes*†, one piécete; *sopas*‡ for three (of course for the liquid alone, as we had a separate charge for the bread), one piécete; three bottles of *rancio* § (for our supper and next day's travelling), each one piécete: total, six piécetes. "And then," added he, "as I do not charge you for the bed, you can give something to the servants." No innkeeper could have made up a more exorbitant account, for all we had got was not worth more than one shilling; but it was of no use to remonstrate, his only answer to our objections being, that withal we were very fortunate in procuring any kind of supper in so wild a country.

"The 26th, having again crossed the Cueillade de Nouri, and redescended the Vallée d'Eynes (instead of returning by the Vallée de Lhou, which we intended to have done had the weather been fine), we arrived late in the afternoon at the cabanasse loaded with plants. This excursion was the richest in our whole tour, as much in the number of specimens as in the variety of species. During the three days we gathered 5500 specimens. We were, no doubt, in the most favourable season; and this excursion being only the second we had yet made, strictly called Pyrenean, it was to be expected that we should find many species scattered throughout the chain; but there were also many very rare species."—Benth.

(To be continued.)

* The *piécete* is precisely a shilling sterling

† *Rostes:* ham usually very dry, and extremely salt, fried in olive-oil, which, both in Roussillon and Catalonia, is almost always rancid.

‡ *Sopas à l'aigo*, literally *water-soup*. In a pot containing about four bottles of water, a head of garlic is boiled, with about two ounces of fat of bacon and a little salt. This liquor is poured on slices of black bread. The happy peasantry prefer the addition of a few spoonfuls of rancid oil, and this constitutes their *sopas à l'oillé*.

§ *Rancio*, wine at first black and thick, made in the maritime districts of Roussillon and Catalonia. At the end of ten or twelve years in the plain, or of two or three in the mountains, it becomes clear, loses much of its colour, and acquires a peculiar flavour, which is called *rance*. It is then an excellent wine, and of great value; but the honest curate of Nouri pocketed at least 150 per cent. on what he provided us with.

Narrative of an Attempt to reach the North Pole, in Boats fitted for the purpose, and attached to His Majesty's ship Hecla, in the year 1827, *under the command of Captain W. E.* Parry, *R. N., F. R. S. L., &c.* 4to. Murray 1828.

A copy of Captain Parry's Narrative having just reached us, we hasten to lay before our readers a few of the many interesting details it contains. This remarkable enterprise was undertaken under the auspices of the Lords of the Admiralty, at the suggestion of Captain Parry, and the recommendation of the Royal Society of London. Its professed object was to attempt reaching the North Pole, by means of travelling with sledge-boats over the ice, or through any space of open water that might occur. So early as the year 1815, the celebrated navigator William Scoresby jun. in a highly interesting memoir, read before the Wernerian Society, and published in the second volume of their memoirs, proposed a plan for travelling over the ice to the North Pole. Afterwards, a similar project was suggested by Captain Franklin; and this finally led to the proposal of Captain Parry, which met with the approbation and support of Government.

The Hecla, already famous in the annals of Arctic enterprise, which had so often braved the storms and ices of the north, was again commissioned. A crew and officers familiar with the Arctic Seas were selected, and every arrangement made to secure their health and comfort. The Chief of the Admiralty, Lord Melville, having visited the Hecla, and expressed his approbation of the equipment, orders for sailing were issued. On the 4th of April 1827 the expedition left the shores of England, bearing with it the wishes and hopes of Britain, and indeed of the civilized world, for its safety and success.

After an agreeable voyage, they reached the interesting station of Hammerfest, at the northern extremity of Norway, on the 19th of April. Here they remained until the 29th, on which day they set sail for Spitzbergen. After encountering much opposition from the ice and the weather, Captain Parry succeeded, but not until the 20th of June, in securing the Hecla, in a harbour in Spitzbergen, which he named Hecla Cove. On the 21st of June

he left the ship, with two boats, which he named the Enterprize and Endeavour, Mr Beverly being attached to Captain Parry's, and Lieutenant Ross, accompanied by Mr Bird, to the other. "Besides these," says Captain Parry, "I took Lieutenant Crozier, for the purpose of carrying some of our weight as far as Walden Island, and also a third store of provisions, to be deposited on Low Island, as an intermediate station between Walden Island and the ship. As it was still necessary not to delay our return beyond the end of August, the time originally intended, I took with me only 71 days' provisions, which, including the boats, and every other article, made up a weight of 200 lb. per man; and, as it appeared highly improbable, from what we had seen of the very rugged nature of the ice we should first have to encounter, that either the rein-deer, or the snow-shoes, or the wheels, would be of any service for some time to come, I gave up the idea of taking them. Having received the usual salutation of three cheers from those we left behind, we paddled through a quantity of loose ice at the entrance of the bay, and we steered, in a perfectly open sea, and with calm and beautiful weather, for Low Island, which we reached at half past two in the morning of the 22d June. Having deposited the provisions, we set off for Walden Island, which was soon reached, and another deposit of provisions made." Lieutenant Crozier now parted from them, and the boats pursued their course northwards. The following is Captain Parry's account of their mode of travelling*:

"Our plan of travelling," he says, speaking of the journey over the ice after leaving the Hecla, "being nearly the same throughout this excursion, after we first entered upon the ice, I may at once give some account of our usual mode of proceeding. It was my intention to travel wholly at night, and to rest by day, there being, of course, constant daylight in these regions during the summer season. The advantages of this plan, which was occasionally deranged by circumstances, consisted, first, in our avoiding the intense and oppressive glare from the snow during the time of the sun's greatest altitude, so as to prevent, in some degree, the painful inflammation in the eyes called 'snow-blindness,' which is common in all snowy countries. We also thus enjoyed greater warmth during the hours of rest, and had a better chance of drying our clothes; besides which, no small advantage was derived from the snow being harder at night for travelling. The only disadvantage of this plan was, that the fogs were somewhat more frequent and more thick by night than by day, though, even in this respect, there was less difference than might have been supposed; the temperature during the twenty-four hours under-

* Narrative, p. 53.

going but little variation. This travelling by night, and sleeping by day, so completely inverted the natural order of things, that it was difficult to persuade ourselves of the reality. Even the officers and myself, who were all furnished with pocket chronometers, could not always bear in mind at what part of the twenty-four hours we had arrived; and there were several of the men who declared, and I believe truly, that they never knew night from day during the whole excursion. When we rose in the evening, we commenced our day by prayers, after which, we took off our fur sleeping-dresses, and put on those for travelling; the former being made of camblet, lined with racoon-skin, and the latter of strong blue box-cloth. We made a point of always putting on the same stockings and boots for travelling in, whether they had dried during the day or not; and I believe it was only in five or six instances, at the most, that they were not either still wet or hard-frozen. This, indeed, was of no consequence, beyond the discomfort of first putting them on in this state, as they were sure to be thoroughly wet in a quarter of an hour after commencing our journey; while, on the other hand, it was of vital importance to keep dry things for sleeping in. Being 'rigged' for travelling, we breakfasted upon warm cocoa and biscuit, and after stowing the things in the boats and on sledges, so as to secure them as much as possible from wet, we set off on our day's journey, and usually travelled from five to five and a half hours, then stopped an hour to dine, and again travelled four, five, or even six hours, according to circumstances. After this we halted for the night, as we called it, though it was usually early in the morning, selecting the largest surface of ice we happened to be near for hauling the boats on, in order to avoid the danger of its breaking up, by coming in contact with other masses, and also to prevent drift as much as possible. The boats were placed close alongside each other, with their sterns to the wind, the snow or wet cleared out of them, and the sails, supported by the bamboo masts and three paddles, placed over them as awnings, an entrance being left at the bow. Every man then immediately put on dry stockings and fur boots, after which we set about the necessary repairs of boats, sledges, or clothes; and, after serving the provisions for the succeeding day, we went to supper. Most of the officers and men then smoked their pipes, which served to dry the boats and awnings very much, and usually raised the temperature of our lodgings 10 or 15 degrees. This part of the twenty-four hours was often a time, and the only one, of real enjoyment to us; the men told their stories, and 'fought all their battles o'er again,' and the labours of the day, unsuccessful as they too often were, were forgotten. A regular watch was set during our resting-time, to look out for bears, or for the ice breaking up around us, as well as to attend to the drying of the clothes, each man alternately taking his duty for one hour. We then concluded our day with prayers, and having put on our fur dresses, lay down to sleep, with a degree of comfort which perhaps few persons would imagine possible under such circumstances; our chief inconvenience being, that we were somewhat pinched for room, and therefore obliged to stow rather closer than was quite agreeable. The temperature, while we slept, was usually from 36° to 45°, according to the state of the external atmosphere; but on one or two occasions, in calm and warm weather, it rose as high as 60° to 66°, obliging us to throw off a part of our fur dress. After we

had slept seven hours, the man appointed to boil the cocoa roused us, when it was ready, by the sound of a bugle; when we commenced our day in the manner before described. Our allowance of provisions for each man per day was as follows:—

Biscuit - - -	10 ounces.
Pemmican - -	9 do.
Sweetened Cocoa Powder -	1 do. to make one pint.
Rum - - -	1 gill.
Tobacco - - -	3 ounces per week.

Our fuel consisted entirely of spirits of wine, of which two pints formed our daily allowance, cocoa being cooked in an iron boiler over a shallow iron lamp with seven wicks,—a simple apparatus, which answered our purpose remarkably well. We usually found one pint of the spirits of wine sufficient for preparing our breakfast; that is, for heating twenty-eight pints of water, though it always commenced from the temperature of 32°. If the weather was calm and fair, this quantity of fuel brought it to the boiling point in about an hour and a quarter; but more generally the wicks began to go out before it had reached 200°. This, however, made a very comfortable meal to persons situated as we were. Such, with very little variation, was our regular routine during the whole of this excursion."

The quantity of rain which fell was truly extraordinary. Captain Parry remarks, on the 26th June, that they had already experienced, in the course of this summer, more rain than during the whole seven previous summers *taken together*, though passed in latitudes from 7° to 15° lower than this.

The expedition, in its progress northwards, experienced perpetual difficulties and delays from the broken state of the ice, and from its nowhere occurring in fields. The following observations convey a striking picture of the nature of their travelling *:—

"As soon as we landed on a floe-piece, Lieutenant Ross and myself generally went on a-head, while the boats were unloading and hauling up, in order to select the easiest road for them. The sledges then followed in our track, Messrs Beverly and Bird accompanying them, by which the snow was much trodden down, and the road thus improved for the boats. As soon as we arrived at the other end of the floe, or came to any difficult place, we mounted one of the highest hummocks of ice near at hand, (many of which were from fifteen to five and twenty feet above the sea) in order to obtain a better view around us; and nothing could well exceed the dreariness which such a view presented. The eye wearied itself in vain to find an object but ice and sky to rest upon; and even the latter was often hidden from our view by the dense and dismal fogs which so generally prevailed. For want of variety, the most trifling circumstance engaged a more than ordinary share of our atten-

* Narrative, p. 67.

tion; a passing gull, or a mass of ice of unusual form, became objects which our situation and circumstances magnified into ridiculous importance; and we have since often smiled to remember the eager interest with which we regarded many insignificant occurrences. It may well be imagined, then, how cheering it was to turn from this scene of inanimate desolation, to our two little boats in the distance, to see the moving figures of our men winding with their sledges among the hummocks, and to hear once more the sound of human voices breaking the stillness of this icy wilderness. In some cases, Lieutenant Ross and myself took separate routes to try the ground, which kept us almost continually floundering among deep snow and water. The sledges having then been brought up as far as we had explored, we all went back for the boats; each boat's crew, when the road was tolerable, dragging their own, and the officers labouring equally hard with the men. It was thus we proceeded for nine miles out of every ten that we travelled over ice: for it was very rarely indeed that we met with a surface sufficiently level and hard to drag all our loads at one journey; and in a great many instances, during the first fortnight, we had to make three journeys with the boats and baggage; that is, to traverse the same road five times over.

We halted at eleven P. M. on the 1st, having traversed from ten to eleven miles, and made good, by our account, seven and a half in a N. by W. direction. We again set forward at ten A.M. on the 2d, the weather being calm, and the sun oppressively warm, though with a thick fog. The temperature in the shade was 35° at noon, and only 47° in the sun; but this, together with the glare from the snow, produced so painful a sensation in most of our eyes, as to make it necessary to halt at one P. M. to avoid being blinded. We therefore took advantage of this warm weather to let the men wash themselves, and mend and dry their clothes, and then set out again at half-past three. The snow was, however, so soft as to take us up to our knees at almost every other step, and frequently still deeper; so that we were sometimes five minutes together in moving a single empty boat, with all our united strength. It being impossible to proceed under these circumstances, I determined, by degrees, to fall into our night travelling again, from which we had of late insensibly deviated. We therefore halted at half-past five, the weather being now very clear and warm, and many of the people's eyes beginning to fail. We did not set out again until after midnight, with the intention of giving the snow time to harden after so warm a day; but we found it still so soft as to make the travelling very fatiguing. Our way lay at first across a number of small loose pieces, most of which were from five to twenty yards apart, or just sufficiently separated to give us all the labour of launching and hauling up the boats, without the advantage of making any progress by water; while we crossed, in other instances, from mass to mass, by laying the boats over as bridges, by which the men and the baggage passed. By these means, we at length reached a floe, about a mile in length, in a northern direction; but it would be difficult to convey an adequate idea of the labour required to traverse it. The average depth of snow upon the level parts was about five inches, under which lay water four or five inches deep; but the moment we approached a hummock, the depth to which we sank increased to three feet or more, rendering it difficult at times to obtain sufficient footing

for one leg to enable us to extricate the other. The pools of fresh water had now also become very large, some of them being a quarter of a mile in length, and their depth above our knees. Through these we were prevented taking the sledges, for fear of wetting all our provisions; but we preferred transporting the boats across them, notwithstanding the severe cold of the snow-water, the bottom being harder for the "runners" to slide upon. On this kind of road we were, in one instance, above two hours in proceeding a distance of one hundred yards."

In defiance of these overpowering difficulties, they continued to struggle towards the north, but with little success. Their progress was very slow; the quantity of rain which fell astonished every one; and the high state of the thermometer was equally a subject of wonder. But a principal obstacle to their progress northward, and one which at length forced Captain Parry to return, was the set of the arctic water towards the south. It moved at the rate of 4 miles per day; and, when assisted by a northerly wind, which unfortunately set in, forced the floating ice on which they dragged their boats, nearly as fast south as they dragged them north. On the 10th of July, they met with fresh-water lakes on the ice, as mentioned in the following extract from the narrative.

"Soon after midnight, the rain being succeeded by one of the thickest fogs I ever saw, we again proceeded, groping our way almost yard by yard from one small piece of ice to another, and were very fortunate in hitting upon some with level surfaces, and also a few tolerable sized holes of water. At half-past two we reached a floe, which at first appeared a level and large one, but on landing we were much mortified to find it so covered *with immense ponds, or rather small lakes of fresh water*, that, to accomplish two miles in a north direction, we were under the necessity of walking three or four, the water being too deep for wading, and from 200 yards to one-third of a mile in length. Towards the northern margin, we came among large hummocks, having very deep snow about them, so that this floe, which had appeared so promising, proved very laborious travelling, obliging us, in some parts, to make three journeys with our loads; that is, to traverse the same road five times over *."

On the 12th July, they reached north Lat. 82° 14′ 28.″ The day was remarkably clear and fine, and the thermometer from 35° to 36° F.

"Setting out again (says the narrator) we crossed a small lane of water to another floe, but this was so intersected with ponds, and by streams running into the sea, that we had to make a very circuitous route, some of the ponds being half a mile in length. If any thing could have compensated for the delay thus occasioned us, it would have been the beautiful blue colour

* Narrative, p. 76.

peculiar to these superglacial lakes, which is certainly one of the most pleasing tints in nature. Notwithstanding the immense quantity of water still upon the ice, and which always afforded us a pure and abundant supply of this indispensable article, we now observed a mark around the banks of the pond, shewing that the water was less deep in them by several inches than it had been somewhat earlier in the summer; and, indeed, from about this time, some small diminution of its quantity began to be perceptible to ourselves.*"

On the 14th and 15th July, the rain was excessive, at times pouring down in torrents, and this, too, in the arctic ocean, beyond north Lat. 82° 14'. On Monday 16th July, in north Lat. 82° 26' 44", east Long. 20° 32' 13", the thermometer in the shade was $37\frac{3}{4}$°, in the sun 47°; a blackened bulb raised it to $51\frac{1}{2}$°; and the same thermometer when held against the black painted sides of the boat rose to $58\frac{1}{2}$°. They saw a mallemuck and a Ross gull, and a *couple of flies were found upon the ice.* At seven o'clock on the evening of the same day, it was so warm in the sun, though the temperature in the shade was only 35°, that the tar was running out of the seams of the boats; and a blackened bulb, when held against the paint-work, raised the thermometer to 72°. The temperature of the sea was 34°. July 17., in north Lat. 82° 32' 10", Captain Parry remarks, "proved one of the warmest and most pleasant days to the feelings, that we had during the whole time we were upon the ice; the thermometer in the shade being from 36° to 40° for several hours, and in the sun from 42° to 51°." On the 19th July, towards midnight, they had smart showers of rain, with dry clear intervals between them, just as on an April day in England. This kind of weather, which continued for several hours, harassed the men very much. On the morning of the 20th July, it is remarked, "we halted at 7 A. M., having by our reckoning accomplished $6\frac{1}{2}$ miles in a N. N. W. direction, the distance traversed being $10\frac{1}{2}$ miles. It may, therefore, be imagined how great was our mortification in finding that our latitude, by observation at noon, was only 82° 36' 52", being less than five miles to the northward of our place at noon on the 17th, since which time we had certainly travelled twelve in that direction."

On the 23d July, their latitude was not more than 82° 43' 32" north, notwithstanding the distance which they had travelled over the ice On the afternoon of this day, a beautiful natural phe-

* Narrative, p. 80.

nomenon was observed. A broad white fog-bow first appeared opposite the sun, as was very commonly the case; presently it became strongly tinged with the prismatic colours, and soon afterwards no less than five other complete arches were formed within the main bow, the interior ones being gradually narrower than those without, but the whole of them beautifully coloured. The larger bow, and the one next within it, had the red on the outer or upper side of the circle, the others on the inner side. Lieutenant Ross measured the altitude of the outer arch, which was 20° 45′ in the centre, its extent at the horizon 72½°; the altitude of the sun, which was bright at the time, being 20° 40′. The fog was quite wet, while the smaller bows were *visible*, which was only twenty minutes; though the large one remained, as usual, for hours together. On the 25th July, it is remarked, "so small was the ice now around us, that we were obliged to halt for the night at 2 A. M., being upon the only piece in sight in any direction, on which we could trust the boats while we rested." Such was the ice in the latitude of 82¾°.

The drift to the southward being much increased by a northerly wind, and little or no progress being made, Captain Parry, on the 26th July, determined on abandoning this most hopeless undertaking.

"It had for some time past been too evident that the nature of the ice with which we had to contend was such, and its drift to the southward, especially with a northerly wind, so great, as to put beyond our reach any thing but a very moderate share of success in travelling to the northward. Still, however, we had been anxious to reach the highest latitude which our means would allow; and, with this view, although our whole object had long become unattainable, we pushed on to the northward for thirty-five days, or until half our resources were expended, and the middle of our season arrived. For the last few days, the eighty-third parallel was the limit to which we had ventured to extend our hopes; but even this expectation had become considerably weakened since the setting in of the last northerly wind, which continued to drive us to the southward, during the necessary hours of rest, nearly as much as we could gain by eleven or twelve hours of daily labour. Had our success been at all proportionate to our exertions, it was my full intention to have proceeded a few days beyond the middle of the period for which we were provided, trusting to the resources we expected to find at Table Island. But this was so far from being the case, that I could not but consider it as incurring useless fatigue to the officers and men, and unnecessary wear and tear for the boats, to persevere any longer in the attempt. I determined, therefore, on giving the people one entire day's rest, which they very much needed, and time to wash and mend their clothes, while the offi-

cers were occupied in making all the observations which might be interesting in this latitude; and then to set out on our return on the following day. Having communicated my intentions to the people, who were all much disappointed in finding how little their labours had effected, we set about our respective occupations, and were much favoured by a remarkably fine day.

"The dip of the magnetic needle was here 82° 21′ 6″, and the variation 18° 10′ westerly, our latitude being 82° 40′ 23″, and our longitude 19° 25′ east of Greenwich. *The highest latitude we reached was probably at seven* A. M. *on the 23d, when, after the midnight observation, we travelled, by our account, something more than a mile and a half, which would carry us a little beyond* 82° 45′. Some observations for the magnetic intensity were obtained at this station. We here found no bottom with 500 fathoms of line; the specific gravity of some water brought up from that depth was 1.0340, being at the temperature of 37°, when weighed. A Six's thermometer attached to the lead failed to indicate the temperature below, owing to the mercury rising past the index. The sea-water from the surface was, as usual, near the ice, in the summer time, so nearly fresh as to require only three grains to be added to the hydrometer; and at six fathoms below the surface, it was 1 0225, at temperature 37°. At the extreme point of our journey, our distance from the Hecla was only 172 miles in a S. 8° W. direction. To accomplish this distance we had traversed, by our reckoning, 292 miles, of which about 100 were performed by water, previously to our entering the ice. As we travelled by far the greater part of our distance on the ice three, and not unfrequently five times over, we may safely multiply the length of the road by 2½; so that our whole distance, on a very moderate calculation, amounted to 580 geographical, or 668 statute, miles, being nearly sufficient to have reached the Pole in a direct line. Up to this period we had been particularly fortunate in the preservation of our health; neither sickness nor casualties having occurred among us, with the exception of the trifling accidents already mentioned, a few bowel complaints, which were soon removed by care, and some rather troublesome cases of chilblains, arising from our constant exposure to wet and cold.

"Our day of rest proved one of the warmest, and most pleasant to the feelings, we had yet had upon the ice, though the thermometer was only from 31° to 36° in the shade, and 37° in the sun, with occasional fog; but to persons living constantly in the open air, calm and tolerably dry weather affords absolute enjoyment, especially by contrast with what we had lately experienced. Our ensigns and pendants were displayed during the day; and sincerely as we regretted not having been able to hoist the British flag in the highest latitude to which we had aspired, we shall perhaps be excused in having felt some little pride in being the bearers of it to a parallel considerably beyond that mentioned in any other well authenticated record *."

The journey back to Spitzbergen, although more expeditious than that towards the Pole, was attended with great fatigue and much danger. On the 2d of August the travellers met with *red snow*, of which the following account is given:

* Narrative, p. 102-107.

"In the course of this day's journey we met with a quantity of snow tinged, to the depth of several inches, with some red colouring matter, of which a portion was preserved in a bottle for future examination. This circumstance recalled to our recollection our having frequently before, in the course of this journey, remarked, that the loaded sledges, in passing over hard snow, left upon it a light rose coloured tint, which, at the time, we attributed to the colouring matter being pressed out of the birch of which they were made. To-day, however, we observed, that the runners of the boats, and even our own foot-steps, exhibited the same appearance; and, on watching it more narrowly afterwards, we found the same effect to be produced, in a greater or less degree, by heavy pressure, on almost all the ice over which we passed, though a magnifying glass could detect nothing to give it this tinge. The colour of the red snow which we bottled, and which only occurred on two or three spots, appeared somewhat different from this, being rather of a salmon, than of a rose, colour, but both were so striking, as to be subject of common remark *."

On Sunday, the 5th August, in Latitude 81° 54′ 47″, the air, in the shade, at noon was 35°, and in the sun 42°. This day they rowed across a lake of fresh water on the ice. It was a quarter of a mile long, and varied in depth from two to four feet, which, together with an island situated in the middle of it, the rugged ice, by which it was bounded, and the beautiful blue of the water, gave it a singular and picturesque appearance. On the 11th of August they observed such indications of an open sea as could not be mistaken, much of the ice being "washed" as by a heavy sea, with small rounded fragments thrown on the surface, and a good deal of dirty ice occurring.

"We also," Captain Parry remarks, "met with several pieces of drift wood and birch bark, the first time since we had entered the ice; and the sea was crowded with shrimps and other sea insects, principally the *Clio borealis* and *Argonauta arctica*, on which numerous birds were feeding. After passing through a good deal of loose ice, it became gradually more and more open, till at length, about a quarter before eleven A. M., we heard the first sound of the swell under the hollow margin of the ice, and, in a quarter of an hour, had reached the open sea, which was dashing with heavy surges against the outer masses. We hauled the boats upon one of these to eat our last meal upon the ice, and to complete the necessary supply of water for our little voyage to Table Island, from which we were now distant fifty miles, our latitude being 81° 34′, and longitude 18¼° E. A light air springing up from the north-west, we again launched the boats, and, at eight A. M. finally quitted the ice, after having taken up our abode upon it for forty-eight days †."

On the 12th August they reached the island, or rather rock, to the northward of Table Island, where their provisions had

* Narrative, p. 109.

† Narrative, p. 118.

been deposited; "and," says Captain Parry, "I cannot describe the comfort we experienced in once more feeling a dry and solid footing." Having got the stores into the boats, an attempt was made to land on Table Island, but without success;—they then bore away for Walden Island. The islet which lies off Little Table Island, and which is interesting, as being the most northern land known upon the globe, Captain Parry named Ross's Islet, in honour of Lieutenant Ross, a young officer, distinguished for his great activity, zeal, and intelligence. In a few hours they reached Walden Island, and made good a landing.

"Every thing," says the narrative, "belonging to us was now completely drenched by the spray and snow; we had been fifty-six hours without rest, and forty-eight hours at work in the boats, so that by the time they were unloaded, we had barely strength left to haul them up upon the rock. We noticed, on this occasion, that the men had that wildness in their looks which usually accompanies excessive fatigue, and, though just as willing as ever to obey orders, they seemed at times not to comprehend them. However, by dint of great exertion, we managed to get the boats above the surf; after which, a hot supper, a blazing fire of drift wood, and a few hours' quiet rest, quite restored us."

The next morning a party, under Lieutenant Ross, was sent to the north-east part of the islet, to launch the spare boat left there by Captain Parry's orders, and to bring round the provisions deposited there. Every thing was found undisturbed. At 10 A. M., on the 14th August, they left Walden Island in three boats, and next morning landed on Low Island. On the 16th the expedition set off for the Hecla, but were forced back to Low Island, and could not finally escape from it until the 21st.

"Having now, by means of drift wood, converted our paddles into oars, and being occasionally favoured by a light breeze, with a perfectly open sea, we made tolerable progress, and, at half-past 4 P. M., when within three or four miles of Hecla Cove, had the gratification of seeing a boat under sail, coming out to meet us. Mr Weir soon joined us in one of the cutters; and, after having good accounts of the safety of the ship, and of the welfare of all on board, together with a variety of details, to us of no small interest, we arrived on board at 7 P. M., after an absence of sixty-one days, being received with that warm and cordial welcome which can alone be felt, and not described. The distance traversed during this excursion was 569 geographical miles, but allowing for the number of times we had to return for our baggage during the greater part of the journey over the ice, we estimated our actual

travelling at 978 geographical miles, or 1127 statute miles. Considering our constant exposure to wet, cold and fatigue, our stockings having generally been drenched in snow water twelve hours out of every twenty-four, I had great reason to be thankful for the excellent health in which, upon the whole, we reached the ship."

During the absence of Captain Parry, the officers of the Hecla were actively employed in making observations on the natural history of Spitzbergen, and experiments on magnetism. But for these we cannot afford room at present. The following observations on the climate of Spitzbergen, are novel and interesting: "The officers who remained on board the Hecla during the summer, described the weather as the most beautiful, and the climate altogether the most agreeable, they had ever experienced in the polar regions. Indeed, the Meteorological Journal shews a temperature both of the air and of the sea-water, to which we had before been altogether strangers within the Arctic Circle, and which goes far towards shewing that the climate of Spitzbergen is a remarkably temperate one for its latitude *. It must, however, be observed, that this remark is principally applicable to the weather experienced *near the land*, that at sea being rendered of a totally different character by the almost constant presence of fogs; so that some of our most gloomy days upon the ice were the finest in Hecla cove, where, however, a good deal of rain fell in the course of the summer." The Hecla left Spitzbergen on the 28th of August, but did not arrive in the Thames until the 16th of October.

The following judicious remarks on the nature and practicability of the enterprize in which he had been engaged, which close the narrative, we give in the celebrated navigator's own words.

"*On the nature and practicability of the attempt to reach the North Pole.*—That the object is of still more difficult attainment than was before supposed, even by those persons who were the best qualified to judge of it, will, I believe, appear evident from a perusal of the foregoing pages; nor can I, after much consideration, and some experience of the various difficulties which belong to it, recommend any material improvement in the plan lately adopted. Among the various schemes suggested for this purpose, it has been proposed to set out from Spitzbergen, and to make a rapid journey to the northward, with

* Mr Crowe of Hammerfest, who lately passed a winter on the south-western coast of Spitzbergen, in about Lat. 78°, informed me he had rain at *Christmas*; a phenomenon which indeed would have astonished us at any of our former wintering-stations in a much lower latitude. Perhaps the circumstance of the reindeer wintering at Spitzbergen, may also be considered a proof of a comparatively temperate climate.

sledges or sledge-boats, drawn wholly by dogs or rein-deer; but, however feasible this plan may at first sight appear, I cannot say that our late experience of the nature of the ice which they would probably have to encounter, has been at all favourable to it. It would, of course, be a matter of extreme imprudence to set out on this enterprize without the means of crossing,—not merely narrow pools and "lanes,"—but more extensive spaces of open water, such as we meet with between the margin of the ice and the Spitzbergen shores; and I do not conceive that any boat sufficiently large to be efficient and safe for this purpose, could possibly be managed upon the ice, were the power employed to give it motion dependent on dogs or rein-deer. On the contrary, it was a frequent subject of remark among the officers, that reason was a qualification scarcely less indispensable, than strength and activity, in travelling over such a road; daily instances occurring of our having to pass over difficult places, which no other animal than man could have been easily prevailed upon to attempt. Indeed, the constant necessity of launching and hauling up the boats (which operations we had frequently to perform eight or ten, and on one occasion, seventeen times in the same day) would alone render it inexpedient, in my opinion, to depend chiefly upon other animals; for it would certainly require more time and labour to get them into and out of the boats, than their services in the intervals, or their flesh ultimately used as food, would be worth; especially when it is considered how large a weight of provender must be carried for their own subsistence.

"In case of employing reindeer, which, from their strength, docility, and hardy habits, appear the best suited to this kind of travelling, there would be an evident advantage in setting out much earlier in the year than we did; perhaps about the end of April, when the ice is less broken up, and the snow much harder upon its surface, than at a more advanced part of the season. But this, it must be recollected, would involve the necessity of passing the previous winter on the northern coast of Spitzbergen, which, even under favourable circumstances, would probably tend to weaken in some degree the energies of the men; while, on the other hand, it would be next to impossible to procure there a supply of provender for a number of tame reindeer, sufficient even to keep them alive, much less in tolerable condition, during a whole winter. In addition to this, it may be observed, that any party setting out earlier must be provided with a much greater weight of warm clothing, in order to guard against the severity of the cold, and also with an increased proportion of fuel for procuring water by the melting of the snow, there being no fresh water upon the ice, in these latitudes, before the month of June.

"In the kind of provisions proper to be employed in such enterprizes,—a very important consideration, where almost the whole difficulty may be said to resolve itself into a question of weight,—I am not aware that any improvement could be made upon that with which we were furnished; for I know of none which appears to contain so much nutriment in so small a weight and compass. It may be useful, however, to remark, as the result of absolute experience, that our daily allowance of provisions, although previously tried for some days on board the ship, and then considered to be enough, proved by no means sufficient to support the strength of men living constantly in the open air, exposed to wet and cold for at least twelve hours a-day, seldom enjoying

the luxury of a warm meal, and having to perform the kind of labour to which our people were subject. I have therefore remarked, that, previously to our return to the ship, our strength was considerably impaired; and, indeed, there is reason to believe, that, very soon after entering upon the ice, the physical energies of the men were gradually diminishing, although, for the first few weeks, they did not appear to labour under any specific complaint. This diminution of strength, which we considered to be principally owing to the want of sufficient sustenance, became apparent, even after a fortnight, in the lifting of the bread-bags and other heavy weights; and I have no doubt that, in spite of every care on the part of the officers, as well as Mr Beverly's skilful and humane attention to their ailments, some of the men, who had begun to fail before we quitted the ice, would, in a week or two longer, have suffered very severely, and become a serious incumbrance, instead of an assistance, to our party. As far as we were able to judge, without further trial, Mr Beverly and myself were of opinion, that, in order to maintain the strength of men thus employed, for several weeks together, an addition would be requisite, of at least one-third more to the provisions which we daily issued. I need scarcely remark how much this would increase the difficulty of equipping such an expedition.

"I cannot dismiss the subject of this enterprise, without attempting to explain, as far as I am able, how it may have happened that the ice over which we passed was found to answer so little to the description of that observed by the respectable authorities quoted in a former part of this volume. It frequently occurred to us, in the course of our daily journeys, that this may, in some degree, have arisen from our navigators having generally viewed the ice from a considerable height. The only clear and commanding view on board a ship is that from the crow's-nest; and Phipps's most important remarks concerning the nature of the ice to the north of Spitzbergen, were made from a station several hundred feet above the sea; and, as it is well known how much the most experienced eye may thus be deceived, it is possible enough that the irregularities which cost us so much time and labour, may, when viewed in this manner, have entirely escaped notice, and the whole surface have appeared one smooth and level plain.

"It is, moreover, possible that the broken state in which we unexpectedly found the ice may have arisen, at least in part, from an unusually wet season, preceded, perhaps, by a winter of less than ordinary severity. Of the latter we have no means of judging, there being no record, that I am aware of, of the temperature of that or any other winter passed in the higher latitudes; but, on comparing our meteorological register with some others, kept during the corresponding season, and about the same latitude*, it does appear, that, though no material difference is observable in the mean temperature of the atmosphere, the quantity of rain which we experienced is considerably greater than usual; and it is well known how very rapidly ice is dissolved by a fall of rain. At all events, from whatever cause it may have arisen, it is certain, that, about the meridian on which we proceeded northward in the boats, the sea was in a totally different state from what Phipps experienced, as may

* Particularly that of Mr Scoresby during the month of July, from 1812 to 1818 inclusive, and Captain Franklin's, for July and August 1818.

be seen from comparing our accounts, his ship being closely beset, near the Seven Islands, for several days about the beginning of August; whereas the Hecla, in the beginning of June, sailed about in the same neighbourhood without obstruction, and, before the close of July, not a piece of ice could be seen from Little Table Island.

"I may add, in conclusion, that, before the middle of August, when we left the ice in our boats, a ship might have sailed to the latitude of 82°, almost without touching a piece of ice; and it was the general opinion among us, that, by the end of that month, it would probably have been no very difficult matter to reach the parallel of 83°, about the meridian of the Seven Islands.

An appendix of eighty pages accompanies the narrative, containing, 1. Meteorological journals; 2. Notice respecting chronometers; 3. Observations on the dip of the magnetic needle; 4. Observations on the variation of the magnetic needle made on shore, or on the ice, 1827; 5. Observations on the diurnal variation of the horizontal magnetic needle at Spitzbergen 1827; 6. Observations on the diurnal changes of intensity in the horizontal magnetic needle at Spitzbergen 1827; 7. Temperature and specific gravity of sea water below the surface, 1827. To these follow observations on zoology by Captain Ross, on the plants collected during the expedition by Dr Hooker, and on the rocks and minerals by Professor Jameson.

Having already greatly exceeded our limits, we must delay giving an account of the more scientific department of the work until a future opportunity. The plan of reaching the North Pole being for the present abandoned, we hope that Government will not allow the experience and skill acquired by Captain Parry and his officers in the Arctic Regions to be lost. It is therefore the duty, as it is, we trust, the intention of the Admiralty, speedily to call them again to similar enterprizes. The examination of the east coast of West or Old Greenland, of Spitzbergen, and the sea and fishing-ground to the eastward of that interesting island, are objects worthy the attention of the nation, and the accomplishment of which would shed a lustre on the name and elevated rank of the Lord High Admiral of England.

Observations on the Dissecting and Preparing of the Bodies of Animals. By Professor Carus *.

Though the art of anatomising the bodies of animals is essentially the same as that practised upon the body of man, and though want of space precludes me from treating the subject minutely, I conceive that a few remarks may not be altogether unacceptable to those who feel desirous of pursuing such studies for themselves.

The first thing that I have to observe is, that all dissections of small and soft objects, *e. g.* worms, zoophytes, insects, mollusca, and embryos, where it is desirable to obtain even tolerably accurate results, should be performed *under water*, by which the parts are kept floating and separated from each other, and, consequently, present themselves more distinctly. A very simple contrivance for investigations of this kind may be prepared in the following manner:—A mass of tough wax (not too soft) is to be laid upon one, or more, porcelain saucers or capsules of different sizes, which are then to be put in a warm place until the wax melts so as to cover the surface evenly to the depth of a half or one-third of an inch. If the object to be examined be laid upon this surface, it may be fixed by needles in any position that is wished, and, when covered with clear water, developed and dissected by means of suitable instruments. Of them, the best are very delicate forceps; pointed, well made, sharp-cutting scissars, and small knives like cataract-needles, some round, others with cutting edges, and fixed in slender wooden handles. For separating parts I have also employed small horn probes and fine brushes; whilst, for examining them, a good magnifying glass is frequently indispensable. If it is wished to preserve a preparation thus made, wax, coloured at pleasure as for the purpose of injections, is to be formed into little tablets about one-fourth of an inch thick: one of these is then to be placed upon the saucer or capsule containing the preparation; the latter may then be transferred to it, arranged suitably upon it, fixed there by means of short needles, and both

* From Introduction to Comparative Anatomy by Professor Carus, translated by Gore, vol. ii. p. 389.

together then placed in alcohol. Nor must I forget to mention, that the examination of very delicate organizations may frequently be conducted with greater facility and accuracy, if the object be previously allowed to remain some time in spirits, and thereby to become harder and contracted. This applies particularly to the dissection of nervous organs, and to the examination of very small embryos, of mollusca, and worms.

There are various modes of destroying worms, insects, mollusca, &c. for the purpose of dissecting, without injuring their organization: Mollusca, snails, for instance, as Swammerdam has remarked, are to be allowed to die in water, because by that means their body swells, and all the parts become more distinctly visible; they may afterwards be kept in spirit (though not too long) for dissection. Worms, the larger zoophytes, (for the smaller must be examined whilst alive), caterpillars, &c. and also the smaller amphibia and fishes, are best destroyed by means of spirit: Insects, on the contrary, by being dipped rapidly in boiling water, or in oil of turpentine.

As regards the dissection of larger animals, we may here use with advantage knives of a large size, and instead of forceps, suitable hooks with handles.

In animals of considerable size we can generally make artificial skeletons only, after the bones have been sufficiently cleaned by boiling or maceration. In smaller animals, on the contrary, such as birds, amphibia, and fishes, of which last it is very difficult to make good skeletons, the object will be best accomplished by at once making the bones as clean as possible, without injuring the capsular ligaments, soaking the preparation in water that is incessantly changed, and, lastly, bleaching it for some time in the sun.

Lastly, we may mention injections as affording a very essential assistance in zootomical investigations for physiological purposes: in small animals, and in the more minute parts, these must consist of compositions with wax, very fluid and coloured; but above all of mercury. The latter, however, is not suitable for very soft bodies, *e. g.* medusæ, &c. in which cases we may employ injections of coloured milk, and similar substances.

On the Irritability of the Sensitive Plant. By M. Dutrochet.

M. Dutrochet has collected, into a single volume, the long and important researches which he has made upon the moving powers which act in organised bodies. His experiments on the sensitive plant occupy an essential part of this work. A new procedure, which he has employed in vegetable anatomy, has led him to results which would tend to invalidate a celebrated theory. He asserts, that all the elementary organs of plants, that is to say, the cellules and tubes, of which their body is composed, have an independent existence, and form circumscribed organs; so that these organs would only have, to each other, relations of vicinage, and would not form, by their assemblage, a really continuous tissue. He affirms that there are neither pores nor fissures visible to the microscope in the cellular tissue, any more than in the fibres of vegetables. There are only seen on the walls of these organs, small semitransparent globular bodies, and linear bodies, which become opaque from the action of acids, and are rendered transparent by that of alkalies. M. Dutrochet considers these small bodies as the elements of a diffused nervous system. To the analogies of intimate structure and chemical nature, which he brings forward to support this opinion, the author adds physiological considerations, taken from experiments, which are peculiar to himself, and which, in his opinion, prove that the motions of vegetables are spontaneous; in other words, that they depend upon an internal principle, which immediately receives the influence of external agents. Refusing to admit *sensibility* in vegetables, M. Dutrochet substitutes for this term that of *nervimotility*.

With regard to the organ of motion in the leaves of the sensitive plant, M. Dutrochet has proved, by decisive experiments, that it consists in a bulging of the parenchyma, or of the *cortical medulla*, which is situated at the base of the petiole, and at the base of each of the leaflets of which the leaf is composed. He has discovered, that this organ, to which he has given the name of *bourrelet*, is composed of globular cellules, disposed in longitudinal series, and filled with a coagulable fluid. It is not by means of joints that the sensitive plant, any more than the other irritable vegetables, moves its mobile parts; but by means of a

curvature impressed on these parts in the place where the organ of motion occurs. Thus, in the sensitive plant, it is the bourrelets alone, that, by curving, produce the folding of the leaves. M. Dutrochet has found, that this curvature is the result of a vital elastic power, which even manifests itself in the thin slices that are taken from these bourrelets. He has given the name of *incurvation* to this phenomenon. Thus the vegetable irritability consists only in an *elastic incurvation*, which is sometimes *fixed* and sometimes *oscillatory*. For example, this elastic incurvation is *fixed* in the tendrils of vegetables, in the valves of the ovarium of the balsamine, &c.; it is *oscillatory* in the vegetables that are named *irritable*,—vegetables which present, in their mobile parts, a state of alternating incurvation and straightening.

It has long been known that the sensitive plant presents a phenomenon of sympathic transmission. If one of the leaflets of this plant be slightly burnt with a burning glass, all the leaflets belonging to the same stalk will fold themselves one after another. This motion deserves to be carefully examined; and, in order to determine the part of the stalk by which the transmission in question is operated, M. Dutrochet made several very delicate experiments, from which there results, that it is neither produced by the pith nor the bark, but that it takes place exclusively by means of the woody part of the central system. Inquiring afterwards what, in this woody part, are the special organs of the transmission in question, he arrives at the conclusion of its being effected through the medium of the sap contained in the tubes, which he names *corpusculiferous*. He has found, that the maximum of velocity of this motion of transmission is fifteen millimetres per second in the petioles of the leaves, and only three millimetres per second in the body of the stalk. The state of the temperature does not appear to have any influence upon its velocity.

Light exercises a very remarkable influence upon the irritability of the sensitive plant, the observation of which equally belongs to M. Dutrochet. If a sensitive plant be placed in complete darkness, by covering it with an opaque vessel, it will entirely lose its irritability, and that in a variable time, according to a certain state of depression or elevation of the sur-

rounding temperature. Thus, at a temperature of from 20 to 25 degrees of Reaumur, it requires only four days of darkness to destroy completely the irritability of a sensitive plant; while fifteen days of darkness are required to produce the same effect when the surrounding temperature is within the limits of 10 and 15 degrees; so that, on only taking the degrees of temperature in which the sensitive plant can live, it may be established that the extinction of the irritability of that plant in darkness is operated in a period, the duration of which is in the inverse ratio of the elevation of the temperature.

M. Dutrochet has observed, that the sensitive plant, deprived of its irritability by means of darkness, recovers it by exposure to light; and that this restoring of the conditions of irritability is more rapidly effected, by exposing the plant to the direct light of the sun, than by exposing it merely to the light of day, such as it exists in the shade. From these observations, M. Dutrochet considers light as the external agent from the influence of which vegetables draw the renewal of the conditions of their irritability, or, more generally, of their *motility*,—conditions which are subject to deperdition in the natural state, and which thus require to be continually repaired.

Description of an Improved Air-Pump. By Mr John Dunn, Optician, Edinburgh *. With a Plate.

In the course of my business, having often heard it regretted that the cost of apparatus prevented many gentlemen from engaging in philosophical pursuits, I have made it my study to simplify the construction of those which I have been employed to make, wherever this could be done without impairing the accuracy of their performance.

One of my first efforts was directed to that most valuable instrument the air-pump, which I shall endeavour to shew I have improved so very materially, as to be able to furnish one capable of effecting as complete an exhaustion as the most perfect form of the instrument hitherto devised, and, at the same time, nearly as simple and as cheap as its most imperfect form. I

* Read before the Society for the Encouragement of the Useful Arts, 19th December 1827.

mentioned my views on the subject to several gentlemen qualified to judge of their correctness, and soon had an opportunity of putting them to the test of experiment. I received an order to make one for Mr Lees, lecturer on mechanical philosophy in the School of Arts here, on condition that he was to be permitted to return it, if, on trial, it was not found capable of executing all that I had taught him to expect. This pump, through the kindness of Mr Lees, in whose possession it has been for the last eighteen months, was exhibited to the Society for the Improvement of the Useful Arts, on 19th December 1827 *.

That the peculiarities of the construction of my pump may be more readily perceived, I shall first shortly describe the common construction, and then its most perfect form, as improved by Cuthbertson.

The common air-pump consists of two barrels AA′, Fig. 1., Plate IV, in which the pistons PP′ are fitted and moved by the racks RR′ and pinion O, the pistons being thus raised and depressed alternately by turning the winch W. In the bottoms of the barrels there are openings, communicating with the receiver or bell-glass; over these openings valves of waxed silk or bladder are so placed as to admit of the passage of the air from the receiver through them, but to oppose its passage from the barrels to the receiver. It is obvious, that, on drawing up either of the pistons, a vacuum will be formed under it till the air from the receiver, by its elastic force, opening the valve V or V′, distributes itself equally betwixt the barrel and receiver. Now, as the pistons are furnished with valves PP′ of the same kind, and opening in the same direction as VV′, on pushing either piston down, the air in the under part of the barrel being prevented by the valve at the bottom from returning to the receiver, will open the piston-valve and escape into the apartment, with the air of which the piston-valve communicates; and these effects will follow the raising and depressing of the pistons, as long as the air in the receiver has sufficient elasticity to open

* The instrument had been previously submitted to the examination of Dr Turner, one of the Secretaries of the Society of Arts, who reported that he had minutely examined it, and was perfectly satisfied with its performance. On his representation to the Council of the London University, I have since received an order to make one for the chemical class of that institution.

the valves VV′. When it can no longer effect this, the exhaustion must cease, and, consequently, a near approximation to a vacuum cannot be obtained by means of this construction.

The best method hitherto proposed for effecting a more perfect exhaustion, is that of Cuthbertson, which proceeds upon the principle of opening the valves independently of the elasticity of the air; and, accordingly, he substitutes in the place of the bladder-valves VV′, Fig. 1., the metallic ones VV′ Fig. 2. *, having the wires WW′ attached to them, which slip stiffly in stuffing-boxes in the piston-rods. On raising either piston, the valve V or V′ is opened by the friction of its wire in the stuffing-box, and is shut by its depression; in the former case leaving a free communication betwixt the part of the barrel under the piston, and in the latter case cutting it off. In the pistons he also places metallic valves PP′, to be opened by the descent of the piston-rod, and to be shut by its ascent, the valves in the pistons thus opening and continuing open, while those at the bottom of the barrels are shut, and *vice versa.* Now, as the piston-valves are opening while those at the bottom of the barrels are shutting, Cuthbertson found it necessary (though this is not required in the common pump) to exclude the external air from the barrels.

For this purpose he put air-tight covers CC′ over the barrels, and made the piston-rods move in the air-tight stuffing boxes BB′, and placed metallic valves MM′ in the covers for the egress of the air, to be opened either by its elasticity or by the pistons striking against the projecting points pp' of these valves.

It is also necessary to prevent the return of the air into the pump during the shutting of these valves, which is done by having them immersed in oil.

This construction is certainly, in theory, as near perfection as we are likely to reach by any form of pump, but it is as certainly very complex, and, consequently, very expensive, and liable to go out of repair,—an objection of which those who have been engaged in making these pumps best know the force.

Believing the only useful part of Cuthbertson's invention to be the contrivance for opening the valves at the bottoms of the barrels mechanically, I was of opinion a pump would perform near-

* In figures 2d and 3d only one of the barrels are represented.

ly, or altogether as well, divested of all the other peculiarities of his instrument, and possessing the decided advantages of being cheaper and much more easily kept in order.

Fig. 3. is a section of the barrels of my pump, in which I employ metallic valves $v\, v'$ at the bottom of the barrels, and waxed silk ones S S′ in the pistons, laying aside Cuthbertson's metallic valves in the pistons, removing all his apparatus from the top of the barrels, and *leaving the pistons exposed to the atmosphere*, as I consider all those contrivances to be unnecessary, although it has been uniformly held essential to a good air-pump, since the time of Smeaton's invention, that the pressure of the atmosphere should be taken off the piston-valves; and my reason for doing so is, that the air will be always so compressed in the barrels, by the descent of the pistons, as of itself to have sufficient elastic force to open the silk valves in the pistons, the capacity of the barrels being each several thousand times greater than the space betwixt the two valves, when the piston is at the bottom. In fact, by making the under side of the piston and the bottom of the barrel fit each other, which, with the assistance of the oil employed in the barrels may be done perfectly, there will be no space left but the small hole in the piston to its valve.

For illustration, let us suppose the stroke to be 12 inches, and the diameter of the barrels $2\frac{1}{2}$ inches, or 25 tenths (as is the case in Mr Lees' one), the diameter of the hole *e* one-tenth of an inch, and its length 1 inch, their circles being to each other as the squares of their diameters, we have $1 \times 1 = 1$ for the capacity of the hole, and $25 \times 25 \times 12 = 7500$ for the capacity of the barrels; and consequently air, which, in the receiver was 7000 times rarer than the atmosphere, would have sufficient elastic force to open the valve in the piston; but as this is a degree of rarefaction far beyond what has ever been attained, or even expected, it follows that any greater nicety of construction here is unnecessary.

The above plan may, however, be objected to, on account of its still leaving *something* to depend on the elastic force of the air which, should any one consider desirable to be removed, can be so done by adapting metallic valves I I′ with projecting points $p'\, p'$, to strike against the bottom of the barrels, having the spaces O′ T′, O I, filled with oil, to exclude the external air

during their shutting; but even this small addition I consider wholly unnecessary.

Fig. 4. is a perspective view of the one I made for Mr Lees, which is the best method of fitting them up; but the principle is alike applicable to table air-pumps.

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*Remarks upon the Wasting Effects of the Sea on the shore of Cheshire, between the rivers Mersey and Dee**. By ROBERT STEVENSON, Esq. Civil-Engineer, F. R. S. E., M. W. S., &c. Communicated by the Author.

ON a former occasion, I had the honour to make a few observations, which appeared in the 2d volume of the Society's Memoirs, regarding the encroachment of the sea upon the land generally. The present notice refers only to that portion of the coast which lies between the rivers Mersey and Dee, extending to about seven miles. To this quarter my attention, with that of Mr Nimmo, Civil Engineer, had been professionally directed in the course of last month. In our perambulatory survey we were accompanied by Sir John Tobin, and William Laird, Esq. of Liverpool, along the Cheshire shore, and its connecting sand banks, between Wallasea Pool, in the Mersey, and Dalpool, in the river Dee. Within these estuaries, the shores may be described as abrupt, consisting of red clay and marl, containing many land or boulder stones, of the cubic contents of several tons, and very many of much smaller size, diminishing to coarse gravel. But the foreland, or northern shore, between these rivers, which I am now to notice, is chiefly low ground, and, to a great extent, is under the level of the highest tides. The beach, or ebb, extends from 300 to 400 yards seaward, and, toward low-water-mark, exposes a section of red clay; but, toward high water, it consists of bluish coloured marl, with peat or moss overlaid by sand. This beach, at about half-tide level, presents a curious and highly interesting spectacle of the remains of a *submarine forest.* The numerous roots of trees, which have not been washed away by the sea, or carried off by the neighbouring inhabitants for firewood, are in a very decayed state. The trees seem to have been cut off

* Read before the Wernerian Society, 8th March 1828.

about two feet from the ground after the usual practice in felling timber, and the roots are seen ramifying from their respective stumps, in all directions, and dipping towards the clay subsoil. They seem to have varied in size from 18 inches to perhaps 30 inches in diameter, and, when cut with a knife, appear to be oak. Several of the boles or trunks have also been left upon the ground, and being partly immersed in the sand and clay, are now in such a decomposed state, that, when dug into with a common spade, great numbers of the shell-fish called Pholas candida, measuring about three-fourths of an inch in length, and two inches in breadth, were found apparently in a healthy state. These proofs of the former state of this ebb or shore, now upwards of 20 feet under full tide, having been once dry land to a considerable extent beyond the region of these large forest trees, were rendered still more evident by the occurrence of large masses of greenstone, which, at a former period, had been imbedded in the firm ground here, and especially on the shore within the river Dee. It may farther deserve notice, that the inhabitants of this district have a traditional rhyme, expressive of the former wooded state of this coast, where not a tree is now to be seen, viz. "From Halbre Isle to Birkenhead a squirrel may hop from tree to tree;" that is from the Dee to the Mersey, now presenting a submarine forest.

As these evidences of great changes upon the state and former appearances of the land were highly interesting to the party, and intimately connected with the professional inquiries of myself and colleague, it seemed desirable to get them, if possible, corroborated by oral testimony. Sir John Tobin accordingly, very obligingly, took measures for examining the oldest people in the neighbourhood, as to their recollection of the former state of these shores. In particular, Thomas Barclay, aged 93 "all but two months," by profession a mason and measurer of country work; Henry Youd, labourer, aged 86; and John Crooksan, labourer, aged 80, were examined. Barclay stated, that he had been employed at the erection of the Leasowe landward Lighthouse in the year 1764; that there were then two lighthouses near the shore, for a leading direction to shipping through the proper channel to Liverpool; and that the Seaward Light became uninhabitable, from its being surrounded by the sea. A new light was then built upon Bidstone Hill; and the

present Leasowe Lighthouse, formerly the landward light, which he had assisted in building, became the sea-light. He could not condescend upon the distance between the two original lights, but was certain that it must have been several hundred yards; that he knows that, in the course of thirty years, the shore of the Leasowe lost, *by measurement*, eleven Cheshire roods, or 88 yards; and verily believes, that, since he knew this shore, it has lost upwards of half-a-mile of firm ground. To the correctness of these statements, the other two aged men gave ample testimony; Henry Youd having al[illegible] worked at the Lighthouse.

As to the present state of things, the party alluded to were eye witnesses of the tides, on the 16th, 17th and 18th of February 1828, having exhibited a very alarming example of the encroachments of the sea upon the Leasowe shore. At high-water it came over the bank, and ran in a stream of about half-a-mile in breadth, surrounded the lighthouse, and continued its course through the low grounds toward Wallasea Pool, on the Mersey, thereby forming a new channel, and threatening to lay several thousands of acres of rich arable and pasture lands into the state of a permanent salt lake. The present Leasowe Lighthouse, which, in 1764, was considered far above the reach of the sea, upon the 17th of February last was thus surrounded by salt water, and must soon be abandoned unless some very extensive works be undertaken for the defence of the beach, the whole of the interior lands of the Leasowe being considerably under the level of high-water of spring-tides.

This coast, with its sand banks in the offing; its submarine forest, and the evidence of living witnesses as to the encroachment of the sea upon the firm ground, is altogether highly interesting to the geological and scientific enquirer. The remains of forests in the bed of the ocean occur in several parts of the British coast; particularly off Lincoln; on the banks of the Tay, near Flisk; at Skiel, in the Mainland of Orkney, and in other places, noticed in the Transactions of this Society, and are strong proofs of the encroachment of the sea upon the land. However difficult, therefore, it may be to reconcile the varied appearances in nature, regarding the sea having at one time occupied a higher level than at present, yet its encroachment as a general, and almost universal principle, seems to be beyond

doubt in the present day. Since I had last the honour of addressing the Society on this subject, opportunities have been afforded me of making many additional observations on the British shores; and of personally extending these to almost every port on the Continent, between the Texel and the Garonne. I have also, through the obliging communications of friends, been enabled to extend my inquiries to other quarters of the globe; and I am now prepared to state, that, with a few comparatively trifling exceptions, the sea appears to be universally gaining upon the land, tending to confirm the theory, That debris, arising from the general degradation of the land, being deposited in the bed of the minor seas, is the cause of their present tendency to overflow their banks.

Description of several New or Rare Plants which have flowered in the Royal Botanic Garden, Edinburgh, during the last three months. By Dr Graham.

10*th March* 1828.

Æginetia capitata.

Æ. capitata; herba pilosa, caule radicanti; floribus capitatis.

Description.—*Stem* herbaceous, jointed, rooting, ascending, cylindrical, branched, purple. *Leaves* opposite, petioled, ovate (1½ inch long, above 1 inch broad), spreading, sligotly decurrent along the petiole, veined, veins curved forward, whole more than half the length of the leaf. *Peduncle* axillary, (3 inches) long, sometimes exceeding, sometimes shorter than the leaf, round, tapering a little, spreading. *Stipulæ* filiform, opposite, alternate with the leaves (½ an inch long). *Capitulum* ebracteate, about 12-flowered, few flowers expanded at a time. *Pedicels* very short. *Calyx* adhering to the sides of the germen, extended into four oblongo-spathulate, distant, suberect, persisting segments, equal in length to the tube of the corolla. *Corolla* funnel-shaped, 4-cleft, slightly pubescent without, and pubescence somewhat reflected, tube cylindrical, throat dilated, lined with close yellow pubescence just above the tube; limb while in bud green, afterwards lilac, white towards the throat, segments obovato-elliptical, spreading, revolute, and smooth above. *Stamens* 4, filaments adhering along the inside of the tube of the corolla, free only for a portion at the top about the length of the anthers, to the back of which they are attached; anthers oblong, sometimes nestling among the yellow hairs in the throat of the corolla, in other instances carried up as high as the divisions of the limb, but the length of the free portion of the filaments does not vary; pollen globular, white. *Pistil* single; stigma large, pubescent, white, cleft, segments revolute; style single, filiform, projecting beyond the anthers, but shorter than the limb of the corolla, white; germen inferior, obovate, slightly flattened, bilocular, ovula numerous.

The stem, branches, leaves, stipulæ, petioles, peduncles, and outside of the calyx segments are very hairy, inside of these last less so; hairs long, spreading, somewhat harsh, very slightly glutinous, at least on the parts of the flower.

This plant was raised last year from seeds received in 1826 by Captain Graham of his Majesty's Packet Service from Mr Harris at Rio de Janeiro. It has been kept in the stove, and has flowered in February and March.

I cannot but doubt the propriety of uniting, under one generic name, plants so very different from each other as *Æginetia longiflora* of Cavanilles, and *Bouvardia triphylla;* and I would be disposed to place greater reliance than I do on the intervening teeth of the calyx, as characterizing *Bouvardia*, and distinguishing it from *Æginetia*, were it not that this would separate two plants very intimately allied, *Bouvardia triphylla* and *B. versicolor*, carrying the last to *Æginetia*, which also it resembles more than the other does in the form of corolla. Whatever may be made of these, the subject of the present article must, I think, belong to the same genus with *Æginetia longiflora*, the parts of the flower differing only in the comparatively short tube of the corolla.

Artocarpus integrifolia; Entire-leaved Bread-fruit tree.

A. *integrifolia;* foliis obovato-oblongis, acuminatis, spathæ valvis integerrimis, amentis masculis patentibus.

Description.—*Tree* of great size in its native country (East Indies); our specimen about seven feet high, with brown bark, green on the young shoots, annular, a slight linear furrow passing quite round the stem from the base of each leaf, and being distinct years after the leaf has fallen. *Leaves* scattered, petioled, crowded at the extremities of the branches, obovato-oblong, acuminate, thick, hard, smooth, shining, undulated (6 inches long), middle rib strong, and with the oblique veins prominent behind, veins united by conspicuous arches near the margin, and by transverse less distinct reticulations; margin quite entire. *Male spadix* stipitate, naked, but inclosed, previous to evolution, within the same pointed, smooth, deciduous stipulæ as the terminal bud, club-shaped, round, above two inches long by three-fourths of an inch broad, projected nearly in a straight line from the extremity of the footstalk, covered with innumerable flowers, dull green, its substance soft and spongy, the footstalk passing through its axis, but lost about the middle in the spongy structure around. *Peduncle* about half the length of the spadix, axillary, spreading, stout, green and shining, the leaf from the axil of which it springs deciduous. *Flowers* monandrous, very small, green. *Perianth* sessile, club-shaped, slightly compressed, somewhat succulent, 2-cleft, gaping slightly, segments blunt. *Corolla* awanting. *Filament* arising from the bottom of the perianth, and exserted. *Anther* erect, bilobular, short, yellow.

A plant is known in collections under the name of *Artocarpus integrifolia*, with rough leaves occasionally lobed; but in ours the leaves are all entire, and smooth on both sides. It was received from Kew in 1814, and in January and March this season has for the first time produced several male spadices, but none with female flowers.

Dodonæa attenuata.

Cunningham, in Field's Account of N. S. Wales, p. 353.

D. *attenuata;* foliis lanceolato-spathulatis, apice mucronulatis basi attenuatis, rigidis, verrucosis, denticulatis; floribus dioicis, racemosis, axillaribus terminalibusque, calycibus reflexis, pubescentibus, sub-viscidis.

Description.—*Shrub* erect, stem round; *bark* brown and cracked; *branches* scattered, slightly compressed, twiggy. *Leaves* scattered, sessile, (3½ inches long, ¼ of an inch broad,) spreading, lanceolato-spathulate, with a small mucro at the apex not always distinct, much attenuated at the base, rigid, rough, with warty elevations on the upper side, middle rib strong, and projecting both above and below, veins few and obscure, margins slightly reflected, toothed. *Racemes* terminal or axillary, rarely compound, bracteate, rachis, pedicels, and calyx, slightly hairy and viscid. *Bracteæ* subulate, solitary at the base of each pedicel, and shorter than this. *Male flowers* nodding. *Calyx* segments acute, reflected, concave, light green, falling along with the other parts of the flower by a division of the top

of the pedicel. *Stamens* 8; filaments very short; anthers large, bilobular, and each lobe deeply grooved, bursting along the sides, arranged in a square form around the centre of the flower, yellow; pollen abundant, yellow. *Pistil* abortive. *Female flowers* nodding. *Calyx* segments closely reflected, straight or bent back at the tips, narrower than in the male. *Pistil* single; stigma 3-cleft, twisted; style straight, channelled, twisted, somewhat contracted near the germen, warted, very long (half an inch); *germen* superior, and left quite exposed by the reflected calyx, trigonous, dark green, warted, surrounded by very short abortive filaments.

Seeds of this plant were, in 1824, received from Mr Fraser, Colonial Botanist, New South Wales, who, in communicating a dried specimen, stated it to be "a tall shrub, native of the interior." In this specimen, the leaves are longer and more linear than in the plant described; but there seems reason to think that the leaves vary somewhat in shape, for in another seedling raised from the same package, the lower leaves are much shorter, broadly spathulate, and somewhat lobed, while the upper are long and linear, nearly resembling the native specimen. Both male and female have flowered freely in the greenhouse in the end of February and beginning of March.

I should have described our plant with a mark of doubt as *D. angustissima*, Decand. had not my excellent friend Dr Hooker, whom nothing escapes, called my attention to the single species described in the work above quoted.

Heteropteris fulgens.

H. *fulgens*; foliis ellipticis, mucronulatis, subtus sericeo-ferrugineis, serie glandularum versus margines notatis, superne pilis deciduis ferrugineis tectis, petiolis medio bi-glandulosis; ramulis verrucosis cumque petiolis adpresse ferrugineo-pubescentibus; paniculis terminalibus.

Description.—*Shrub* scandent; *bark* light grey. *Branches* warted, compressed, young shoots pubescent. *Leaves* opposite, on short petioles, elliptical, (4–5 inches long), subcoriaceous, and somewhat undulated, mucronulate, veined; above full green, with a deciduous adpressed pubescence; below a permanent adpressed silky pubescence, mixed with a few coarser and more straggling hairs, and a loose row of small glands along each margin. *Petioles* with two green glands, generally about the middle, but varying both in number and position, yet never awanting in our large plant; when young always yielding a globule of viscid honey, but often withering early, and then appearing abortive. *Panicle* large, long, terminal, bracteate, branches decussating, spreading, two or three rising within each other from the axil of the same bractea, cymose. *Bracteæ* for two or three pairs at the bottom of the panicle in all respects common leaves; above they become small and subulate, generally rather exceeding the longest peduncle from their axil; but the petiole is less altered, and retains its glands. *Pedicels* rising from the axils of small subulate bracteæ, and having two similar opposite ones about their middle, from the axils of which other pedicels arise, with similar structure, and from these others again, in a series lengthening with the vigour of the specimen. *Rachis*, pedicels, and bracteæ pubescent, the pubescence on the whole plant adpressed and rusty, on the pedicels somewhat loose, and on the back of the young leaves pale. *Flowers*, few expanded at a time. *Calyx*, segments 5, small and pointed, erect, connivent at their apices, and covered with rusty adpressed pubescence; glands 8, large, oblong, green, and arranged in pairs on the back of four of the segments, with occasionally the rudiments of a fifth pair on the back of the fifth segment, which, however, is most frequently without glands. *Petals* 5, clawed, oblong, uneven on the surface, keeled, ragged, and reflected at their edges, spreading from between the segments of the calyx; when first expanded of uniform yellow, afterwards orange-red, and yellow only at the edges. *Stamens* 10, equal; filaments much dilated at the base, brown, and united, above subulate, yellow, closely applied to the germen; anthers reflected,

oblong, bilocular, yellow on their inner side, brown without. *Stigmata* capitate. *Styles* 3, stout, equal in length to the stamens, somewhat diverging. *Germen* round, superior, covered with loose yellowish-brown tomentum, trilocular, loculaments monospermous, ovulum pendulous from the central column.

This climber has been long in the stove of the Botanic Garden, Edinburgh, though it is now for the first time in flower; native country unknown. In this, and in other collections, it has been called *Banisteria fulgens*, being probably supposed the plant described under that name by Meyer, considered by Decandolle a variety of *B. ferruginea;* it is certainly not the *B. fulgens* of Linnæus. It may be *Heteropteris nitida*, var. β of Bot. Reg. t. 950. (*Banisteria* of the index). I had referred it to *Heteropteris*, chiefly from the form of the style; and I am since confirmed in this, by finding that the fruit, the only sure mark, exists in Dr Hooker's herbarium. The universality of the petiole glands, the more entire leaf, the less dense, differently branched inflorescence, the much smaller number of flowers expanded on panicles twice the size of that figured, and the constant deficiency in the calyx glands, make me doubt whether this is the plant of the Register; and though it should prove the same, I shall regret less having described it under a different name, as it is there considered only a variety.

Lobelia racemosa.

Bot. Mag. t. 2137.

L. *racemosa;* caule suffruticoso, erecto; foliis lanceolatis, serrato-spinulosis; racemo terminali, pedicellis florem æquantibus, patulis, demum inflexis.

Description.—*Stem* erect, half woody, round (2 feet high), branching from the axils of the leaves near the top as the flower fades. *Leaves* lanceolate, tooth-spinous (9 inches long by 1¼ broad), attenuated at both their extremities, sessile, subdecurrent, scattered, crowded. *Rachis* continuous with the stem, and resembling it, greatly elongated while flowering (at length 2 feet long), tapering slowly. *Pedicels* scattered, very numerous, crowded and spreading while in flower, afterwards removed to a greater distance from each other by the elongation of the rachis, and curved upwards and inwards, flattened, somewhat winged below the middle, where each supports two opposite *bracteæ*, resembling miniature leaves (¼ of an inch long), each also springs from the axil of a similar but much larger *bractea*, which, at the lower part of the raceme, is longer than the pedicel, but towards the top only half its length. *Calyx* segments awl-shaped, sharply serrated, spreading wide, at last reflected, persisting. *Corolla* (1¼ inch long) somewhat plaited, cleft to its base along the upper side, divided nearly to its middle into three segments, which are coiled up backwards, the lateral ones entire and pointed, the central 3-toothed. *Stamens* unconnected only at their base, every where else united by their filaments and anthers into a tube ensheathing the whole of the style; anthers pale leaden coloured, ciliated at their extremities, bursting on their inner side, and discharging at the extremity of the tube a large quantity of white pollen. *Stigma* large, capitate, ciliated at the base, at first included and marked by a transverse fissure, afterwards projected just beyond the tube of the anthers, and divided into two short, broad, revolute segments, covered on their upper surface with short, close, glandular pubescence. *Style* flattened, slightly curved, enlarging a little upwards (about 1 inch long). *Germen* half inferior, conical in its upper part, broad and furrowed in its lower, bilocular; receptacle of the seeds large, attached to the sides of the dissepiment, the transverse section cordate. *Seeds* very numerous.

Ciliæ of the anthers and stigma, and upper surface of the revolute stigma, white; every other part of the plant, except the anthers, green. The whole smooth, except the upper surface of the stigma after the segments become revolute, also the pedicels and upper part of the rachis, which are slightly pubescent. The whole yields a milky, fetid juice, when broken.

I have not any where seen a detailed description of this plant, and the form of the leaves, as stated in the specific character in the Botanical Magazine, does not agree with our plant, or with the figure given. The figure is very characteristic, and was taken from a plant procured from St Christopher's in the West Indies. Our plant was received from Mr Harris of Rio de Janeiro by Captain Graham of his Majesty's Packet Service in 1826, and it has always been kept in the stove.

Mentha? pumila.

M.? *pumila*; caule erecto; calyce 4-fido, ovato; corolla 4-fida, subregulari (clausa ?); filamentis subexsertis, pilis articulatis medio cinctis; foliis verticillatis, quaternis, obovato-lanceolatis, serratis.

Description.—Annual. *Stem* upright, simple, 2 or 3 inches high in our specimens, which are probably small, from having been crowded in the seed-pot, and flowering in December. *Leaves* crowded, verticelled, 4 in each whorl, obovato-lanceolate, sparingly and distantly serrated towards the apex, in our specimens generally only one serrature on each side, frequently two, very rarely three, spreading, veinless, flat, slightly channelled, and having very minute, reflected, adpressed pubescence above, keeled, and sprinkled with minute glandular dots below. *Inflorescence* a terminal capitate spike. *Bracteæ*, one at the base of each flower, obovato-lanceolate, hairy, and strongly ciliated, concave, connivent at the points, and as long as the calyx. *Calyx* ovate, inflated, 4-cleft, segments equal, hairy, connivent, pointed. *Corolla*, 4-toothed, very nearly regular, hairy, ovate (closed ?), longer than the calyx, pink. *Stamens* 4, subexserted, filaments nearly equal, connivent; anthers like rounded, swollen terminations to the filaments, brown, bursting in a line across their extremities; filaments having in their middle a whorl of hairs, appearing through a high magnifying power, like strings of round beads. *Pistil* single; style filiform, exserted; stigma cleft, segments large and revolute; germen 4-lobed, imbedded in the base of the corolla.

The seeds of this plant were obtained from Nepaul by Captain Macgill, and obligingly communicated to us in 1827. The seedlings were kept in the stove, and never transplanted. Unfortunately the whole damped off during December and January, as well those which did not flower as those which did.

I am far from satisfied about the generic name of this plant. Dr Hooker, who kindly sent to me a MS. volume of Flora Indica, pointed out its close resemblance in habit to *Columnea heterophylla*, and also to *Mentha verticillata*, and he thinks it scarcely differs from *M. verticillata* of Don's Prodromus Flor. Nepal., except in size. From *Columnea* it is of course distinguished by being gymnospermous. My difficulty about the genus arises from the calyx and corolla being, if not absolutely, at least very nearly regular; from my not having observed a notch in the lower segment of the former; from the latter being closed, the four segments connivent at the apex; and especially from the structure of the anthers, so very singular, if my examination of them was correct, which I have no reason to doubt. Dr Hooker, however, feels sure of its being as good a *Mentha* as any of the verticelled species; and in deference to that acute observer I leave it in this genus. I cannot, however, think it is either the *M. verticillata* of his MS. volume or of Don, which differ from each other. It differs from the first in the form of the leaves, and in the pubescence of the filaments being confined to a whorl, and from both by having uniformly four leaves in a whorl. I cannot think this last arises from the specimens being smaller than natural, because we had many plants, though all did not flower, and there was not one exception to this structure.

Primula verticillata.

P. *verticillata*; foliis glabris, erectis, spathulato-rhomboideis, rugosis, per petiolos longos decurrentibus, inciso-biserratis, acutis, subtus farinosis; floribus verticillatis, tubo corollæ pedicellum æquanti, laciniis crenulatis (vel integris ?); involucris foliaceis, pentaphyllis, pedicello longioribus.

Description.—*Root* supporting several scapes. *Leaves* suberect, rhomboideo-spathulate, decurrent along petioles longer than themselves, incised, and divisions serrated, convex above, soft, much veined from the middle rib, and somewhat bullate. *Scape* erect, round. *Flowers* verticelled, five in each whorl, bracteate. *Bracteæ*, one to each pedicel, sessile, lanceolate, doubly serrated, but less so than the leaves, nerved and veined. *Pedicels* nearly as long as the bracteæ. *Calyx* 5-cleft, segments erect, or somewhat spreading, pointed and serrated. *Corolla* yellow, scarcely perfumed; tube (⅝ths of an inch long) twice as long as the calyx, round and slightly swollen where it covers the germen, and, in the situation of the stamens, distinctly 5-sided between these two points, and in some degree above the last; throat naked; limb spreading at a right angle, small (less than half an inch across), segments obcordato-rotund, crenate (or entire ?). *Anthers* oblong, nearly sessile in the upper third of the tube. *Stigma* cup-shaped, included, but carried above the stamens; *style* filiform; *germen* globular, green; *ovules* extremely numerous, ranged round the central receptacle, a slender process from which is continued with the style, and may be easily unsheathed from the lower part of this. The outer side of the corolla, both sides of the calyx, the pedicels and scape, the bracteæ and leaves, particularly on their lower sides, are powdery.

We received in 1825 a plant of this species from M. Otto at Berlin, under the name of *P. involucrata*, marked "Egypt," but it suffered so much on the way that it could not be preserved. The subject of the present article was raised from seed, communicated from the same liberal quarter in 1826, and flowered in the beginning of the present month. The divided edge of the corolla seems the only deviation from the essential character of *P. verticillata* of Forskaol, and the analogy of other species, as *P. prænitens*, shows that this cannot be relied upon as a specific distinction.

Celestial Phenomena from April 1. to July 1. 1828, calculated for the Meridian of Edinburgh, Mean Time. By Mr George Innes, Aberdeen.

The times are inserted according to the Civil reckoning, the day beginning at midnight. —The Conjunctions of the Moon with the Stars are given in *Right Ascension.*

APRIL.

D.	H.	′	″		D.	H.	′	″	
2.	5	29	47	☌ ☽ λ ♍	10.	14	36	22	☌ ☽ ♅
2.	19	50	34	☌ ☽ 2 α ♎	12.	6	3	–	☌ ☽ ☿
2.	20	1	51	☌ ☽ ♃	13.	16	41	26	☌ ☽ ε ♓
3.	13	30	32	☌ ☽ 4 ζ ♎	13.	23	55	42	Im. I. sat. ♃
3.	22	6	40	☌ ☽ ϑ ♎	14.				☿ greatest elong
5.	3	33	17	Im. I. sat. ♃	19.	9	14	38	● New Moon.
5.	21	24	25	☌ ♀ η ♉	15.	3	2	45	Im. II. sat. ♃
6.	7	49	46	☌ ♃ 2 α ♎	15.	18	17	25	Im. III. sat. ♃
6.	22	1	47	Im. I. sat. ♃	17.	11	3	14	☌ ☽ 1 θ ♉
7.	7	9	22	☌ ☽ ♂	17.	11	33	43	☌ ☽ 2 θ ♉
7.	12	5	47	☾ Last Quarter.	17.	13	53	53	☌ ☽ ε ♉
8.	0	28	49	Im. II. sat. ♃	17.	22	55	24	☌ ☽ ♀
8.	11	32	51	☌ ☽ β ♑	20.	2	0	33	☉ enters ♉
8.	14	10	8	Em. III. sat. ♃	20.	18	4	54	☌ ☽ ♄
9.	12	15	7	☌ ♀ A ♉	21.	1	49	44	Im. I. sat. ♃

APRIL.

D.	H. ′ ″	
22.	5 12 4	☽ First Quarter.
22.	22 15 13	Em. III. sat. ♃
22.	22 32 58	☌ ☽ 1 α ♋
22.	23 38 58	☌ ☽ 2 α ♋
23.	21 0 24	☌ ☽ ο ♌
24.	7 3 21	☌ ☽ * ♌
26.	9 3 30	☌ ☽ ν ♌
28.	3 43 50	Im. I. sat. ♃
29.	10 12 20	Im. I. sat. ♃
29.	13 43 13	☌ ☽ λ ♍
29.	22 35 27	☍ ☉ ♃
29.	22 40 4	○ Full Moon.
29.	22 40 56	☌ ☽ ♃
30.	0 5 30	Im. III. sat. ♃
30.	2 12 57	Em. III. sat. ♃
30.	3 47 10	☌ ☽ 2 α ♎
31.	2 40 31	☌ ♀ 132 ♉
31.	2 58 18	☌ ♂ 1 ν ♐

MAY.

D.	H. ′ ″	
3.	0 56 23	Em. II. sat. ♃
4.	6 12 24	☌ ☽ ♂
4.	20 50 –	☌ ☿ ο ♓
5.	16 54 43	☌ ☽ β ♑
5.	18 4 36	☌ ☽ ♅
6.	17 24 56	☾ Last Quarter.
7.	2 14 13	Em. I. sat. ♃
7.	4 3 46	Im. III. sat. ♃
8.	20 42 49	Em. I. sat. ♃
10.	2 31 7	Em. II. sat. ♃
10.	23 56 31	☌ ☽ ε ♓
11.	0 2 7	♄ near δ ♊
11.	4 19 31	☌ ☽ ζ ♓
12.	20 50 –	☌ ☽ ☿
13.	2 29 44	☌ ♀ ε ♊
13.	21 41 19	● New Moon.
14.	8 2 6	Im. III. sat. ♃
14.	19 19 9	☌ ☽ 1 θ ♉
14.	19 49 40	☌ ☽ 2 θ ♉
14.	22 10 16	☌ ☽ ε ♉
15.	22 37 7	Em. I. sat. ♃
17.	21 4 43	☌ ☽ ♀
18.	6 15 26	☌ ☽ ♄
19.		♀ greatest elong.
20.	6 28 23	☌ ☽ 1 α ♋
20.	7 34 41	☌ ☽ 2 α ♋
21.	3 17 31	☉ enters ♊
21.	5 4 36	☌ ☽ ο ♌
21.	12 1 10	Im. III. sat. ♃
21.	15 13 21	☌ ☽ * ♌
21.	23 3 4	☽ First Quarter.
22.	23 40 –	☌ ☿ A ♉
23.	0 31 31	Em. I. sat. ♃
23.	5 15 17	☌ ♀ ♄
23.	17 53 10	☌ ☽ ν ♌
23.	15 59 –	Sup. ☌ ☉ ☿
25.	4 45 –	☌ ☿ κ ♉
26.	23 18 21	☌ ☽ λ ♍
27.	2 32 –	☌ ☽ ♃
27.	11 46 –	♂ near ↓ ♐
27.	13 22 22	☌ ☽ 2 α ♎
27.	14 56 –	☌ ♀ κ ♊
27.	20 59 17	Em. II. sat. ♃
28.	6 32 6	☌ ☽ 4 ζ ♎
28.	14 49 31	☌ ☽ ϑ ♎
29.	8 9 40	○ Full Moon.
31.	20 54 35	Im. I. sat. ♃

JUNE.

D.	H. ′ ″	
1.	23 31 53	☌ ☽ β ♑
2.	0 8 16	☌ ☽ ♅
3.	7 50 –	☌ ☿ 132 ♉
3.	23 34 58	Em. II. sat. ♃
4.	22 5 40	Em. III. sat. ♃
4.	22 55 18	☾ Last Quarter.
7.	5 32 2	☌ ☽ ε ♓
7.	9 59 57	☌ ☽ ζ ♓
7.	22 49 9	Em. I. sat. ♃
9.	21 42 –	☌ ☿ ε ♊
11.	2 11 11	☌ ☽ 1 θ ♉
11.	2 41 59	☌ ☽ 2 θ ♉

JUNE.

D.	H. ′ ″		D.	H. ′ ″	
11.	5 4 12	☌ ☽ ι ♊	23.	8 56 33	☌ ☽ λ ♍
11.	23 57 41	Im. III. sat. ♃	23.	9 11 44	☌ ☽ ♃
12.	11 7 31	● New Moon.	24.	16 38 9	☌ ☽ 4 ξ ♎
14.	9 38 –	☌ ☽ ☿	25.	1 0 0	☌ ☽ 2 ♎
14.	19 34 16	☌ ☽ ♄	27.		☿ greatest elong.
16.	4 47 36	☌ ☽ ♀	27.	15 41 8	○ Full Moon.
16.	13 37 48	☌ ☽ 1 α ♋	27.	22 13 22	☌ ☽ ♂
16.	14 44 19	☌ ☽ 2 α ♋	29.	7 59 0	☌ ☽ ♅
17.	12 18 50	☌ ☽ ο ♌	29.	8 21 33	☌ ☽ β ♑
17.	22 31 20	☌ ☽ π ♌	30.	23 1 51	Em. I. sat. ♃
17.	23 48 –	☌ ☿ ♄			
19.	15 50 45	☌ ☽ υ ♌			
20.	14 48 45	☽ First Quarter.			
21.	11 57 3	☉ enters ♋			

Mars will be in ☍ to the ☉ at 2^h 9^m 2^s on the 1st of July.

Times of the Planets passing the Meridian.

APRIL.

D.	Mercury. H. ′	Venus. H. ′	Mars. H. ′	Jupiter. H. ′	Saturn. H. ′	Georgian. H. ′
1	10 42	14 38	5 15	2 6	18 19	7 39
5	10 32	14 41	5 7	1 48	18 5	7 23
10	10 25	14 44	4 56	1 26	17 46	7 3
15	10 25	14 49	4 46	1 5	17 27	6 44
20	10 24	14 53	4 35	0 43	17 9	6 25
25	10 29	14 58	4 22	0 17	16 50	6 6

MAY.

D.	Mercury. H. ′	Venus. H. ′	Mars. H. ′	Jupiter. H. ′	Saturn. H. ′	Georgian. H. ′
1	10 39	15 2	4 8	23 50	16 28	5 43
5	10 46	15 5	3 57	23 32	16 14	5 27
10	10 57	15 8	3 42	23 10	15 56	5 7
15	11 18	15 11	3 27	22 48	15 38	4 47
20	11 40	15 13	3 11	22 27	15 21	4 27
25	12 6	15 14	2 53	22 5	15 4	4 8

JUNE.

D.	Mercury. H. ′	Venus. H. ′	Mars. H. ′	Jupiter. H. ′	Saturn. H. ′	Georgian. H. ′
1	12 42	15 12	2 28	21 35	14 39	3 39
5	13 2	15 11	2 11	21 17	14 25	3 23
10	13 23	15 5	1 49	20 56	14 8	3 3
15	13 38	14 59	1 26	20 35	13 51	2 42
20	13 48	14 48	1 2	20 15	13 42	2 22
25	13 52	14 35	0 36	19 55	13 17	2 2

Proceedings of the Wernerian Natural History Society Continued from p. 182.

1827, *Dec.* 15.—G. A. W. ARNOTT, Esq. V. P. in the chair. —The Secretary read an account of a peculiar species of Porpesse (Delphinus Peronii ?), which abounds off the coast of Van Dieman's Land; communicated by the Rev. John Macgarvie, A. M. The next paper was an account of the Climate and of the Geology of the Harris Islands; by Mr William Macgillivray, who resided there for several years. (For interesting extracts from this paper, see last Number of this Journal, supra, p. 140, *et seq.*) At the same meeting there was read an account of an Optical Illusion or Mirage, called the Fairy Islands, frequently seen off the north coast of Ireland, near the Skerry Islands of Antrim; communicated by Mr Samuel Thomas Greig. And also, a notice from Lieutenant-General the Honourable Sir Charles Colvile, regarding a fine specimen of Hindoo sculpture, presented to the University Museum by the General. The specimen was exhibited to the meeting. It represents the goddess Bhowanee, with her usual attendants. It was found among the ruins of a Brahminical temple in the ancient city of Chandwartie, and apparently belongs to a period corresponding to the beginning of the 12th century of our era.

1828, Jan. 12.—DAVID FALCONAR, Esq. V. P. in the chair. —The Secretary read an account of the habits of a specimen of the *Siren lacertina*, which has been kept alive at Canonmills, near Edinburgh, for more than two years past. (This paper is printed in the present number of this Journal, p. 346, *et seq.*) At the same meeting was read a paper by the Rev. John Macgarvie, on the habits of the large brown Hornet of New South Wales, with a reference to instinct, and particularly illustrative of its mode of forming its hexagonal cells. (This paper is likewise printed in the present Number, p. 237, &c.)

Professor Jameson then exhibited some of the birds collected by Captain Parry during his last voyage to the Arctic Regions, two of them (a little auk and a guillemot) killed beyond north latitude 81°; and specimens of the rocks of Ross Island, chiefly gneiss, the most northern known land of the globe.

Jan. 26.—Robert Jameson, Esq. P. in the chair.—Dr Grant read the first part of his account of the anatomy of the Perameles nasuta of Geoffroy, a rare marsupial animal from New Holland. The Rev. Dr David Scot of Corstorphine then read a memoir on the Emerald of the Ancients. At the same meeting was read a notice by Mr G. Milroy, regarding the habits of a living specimen of the Jacchus vulgaris or Ouistiti, lately brought by him from Bahia; and the specimen was exhibited to the meeting.

Feb. 9.—Robert Jameson, Esq. P. in the chair.—The Secretary read a notice respecting the occurrence of a rare bird, the Cursorius isabellinus, or swiftfoot, in Leicestershire; communicated by Prideaux John Selby, Esq. of Twizel House.

Mr James Stuart Menteath, younger of Closeburn, then read a memoir on the Geology of Nithsdale, chiefly as connected with useful purposes, and contrasted with that of the neighbouring valleys; illustrated by maps and specimens. (The first part of this interesting communication will be found in the present Number of this Journal, p. 614, &c.)

SCIENTIFIC INTELLIGENCE.

ASTRONOMY.

1. *Appendix to the Nautical Almanack.*—The Board of Longitude has published an appendix to the Nautical Almanack for 1828, which contains a list of moon-culminating stars. This has been done as the beginning of an experiment which will be continued, until it is ascertained whether such a list is likely to be permanently useful.

2. *Reduction of the Observations made by Sir T. M. Brisbane in the Southern Hemisphere.*—The Royal Society of London is about to undertake the reduction of the observations made by Sir T. M. Brisbane in the Southern Hemisphere. It is expected that this labour will tend to settle the places of the principal stars in that region of the heavens, a thing much wanted.

3. *Voyage of Experiment and Discovery.*—Captain H. Forster is appointed to the command of the ship Chanticleer for a

voyage of experiment and discovery. He will probably sail round the world before he return. He takes out a great number of chronometers, pendulums, and various other instruments.

4. *Charts of the Zodiacal Stars.*—A member of the Astronomical Society in London, distinguished for his zeal and liberality in whatever relates to that science, has undertaken a set of charts of the zodiacal stars contained in the catalogue of the Astronomical Society. One is already engraved.

METEOROLOGY.

5. *Meteorological Table, extracted from the Register kept at Kinfauns Castle, North Britain. Lat. 56° 23′ 30.″ Above the Level of the Sea 140 Feet.*

1827.	Morn. ½ past 9. Mean Height of Barom.	Morn. ½ past 9. Mean Height of Therm.	Even. ½ past 8. Mean Height of Barom.	Even. ½ past 8. Mean Height of Therm.	Mean Temp. by Six's Therm.	Depth of Rain in Garden.	No. of Days. Rain or Snow.	No. of Days. Fair.
January,	29.597	37.226	29.606	37.613	37.516	2.50	17	14
February,	29.980	36.464	29.952	36.536	36.428	1.90	4	24
March,	29.295	42.032	29.343	40.161	40.742	2.70	17	14
April,	29.743	47.367	29.731	4[illegible] 200	46.500	3.70	14	16
May,	29.548	53.355	29.541	50.935	51.452	3.20	17	14
June,	29.623	59.433	29.634	54.600	56.667	1.50	11	19
July,	29.761	62.226	29.774	57.903	58.806	2.90	10	21
August,	29.826	59.968	29.844	57.065	58.226	2.70	13	18
September,	29.755	57.666	29.753	55.767	56.767	1.50	10	20
October,	29.582	53.032	29.594	[illegible]2.710	52.710	5.70	17	14
November,	29.779	44.767	29.770	45.233	39.566	2.20	7	23
December,	29.381	43.710	29.371	43.742	43.677	4.40	17	14
Average of the Year,	29.656	49.770	29.661	48.122	48.25[illegible]	34.90	154	211

ANNUAL RESULTS.

MORNING.

Barometer.			*Thermometer.*	
Highest, 9th Feb. 30.52	Wind SW.		Highest, 16th July, 68°	Wind SW.
Lowest, 6th Mar. 28.44	SW.		Lowest, 16th Feb. 28	W.

EVENING.

Highest, 8th Feb. 30.53	Wind SW.		Highest, 25th July, 64°	Wind NW.
Lowest, 6th Mar. 28.58	SW.		Lowest, 3d Jan. 20	SW.

Weather.	*Days.*	*Wind.*	*Time.*
Fair, - - -	211	N. & NE. - -	7
Rain or Snow, - -	154	E. & SE. - -	105
		S. & SW. - -	146
	365	W. & N. NW. - -	107
			365

Extreme Cold and Heat by Six's Thermometer.

Coldest,	3d January	Wind SW.	18°
Hottest,	16th July,	SW.	75
Mean Temperature for 1827,			48 255

Result of Two Rain Gauges.

	Inches.
1. Centre of Kinfauns Garden, about 20 feet above the level of the Sea,	34.90
2. Square Tower, Kinfauns Castle, about 140 feet,	35.60

6. *Mr Watt's Solar and Lunar Compasses.*—Mr Watt having observed that the forms of the solar compass, which were described in a preceding number of this Journal, although they exhibited well the phenomena mentioned from the vernal to the autumnal equinox, yet did not move so readily when the sun's declination became greater, finds that the motions become very distinct, by adopting the following improvement. Stretch a circular disc of dark-coloured velvet, of about four inches diameter, upon two very thin slips of light wood, or upon two feathers, placed across each other at right angles; render about 25 grains weight of pure filings of steel magnetic, by putting them between the folds of a piece of paper, and drawing the ends of two magnets about thirty times across them. Rub the filings over the whole face of the velvet disc, they will then sink into the spaces formed by the piles of the silk. Let this be affixed to the end of a very light bar of wood, or to the opaque part of a writing quill, four inches long, by a fine needle passed through the disc: make a small perforation in the wood or quill, at the distance of one-third of its length, measuring from the point to which the disc is attached: press a small agate or glass capsule into the aperture: without any wax or fixture, the elasticity of the wood or quill keeps it sufficiently firm: balance it on a fine steel point, and let the cover be put over it. This instrument moves to the influence of the solar beam from morning to evening, on our shortest days, even when the thermometer stands at freezing, and though the rays fall upon it through the glass of a window and the glass of the cover:—and the motion of the balancing bar is as slow, equal, and constant, when the sky is clear, as the shadow of the gnomon of a dial.—Mr Watt has also observed, that this instrument, and several other bodies, clearly indicate by their motion the attractive influence of the lunar beam. An account of the experiments, directed to ascer-

tain this property in the lunar rays, will be communicated afterwards. M. W.

CHEMISTRY.

7. *Animal Matter in Mineral Waters.*—A green matter is deposited from the water of the hot alkaline springs of Vichy, in France. It was analyzed by Vauquelin, who found it to resemble the white of an egg. It is worthy of remark, that springs in the south of France, and in the north of Italy, which issue from primitive rocks, should contain this substance, whose composition is so nearly the same as that of organic matter.

8. *Crystals of Oxalate of Lime in Plants.*—M. Raspail has read a memoir to the Academy of Sciences, to prove the analogy which exists in arrangement between the crystals of silica, which are found in sponges, and those of oxalate of lime occurring in the tissue of phanerogamous plants. The latter crystals were observed, for the first time, by Rafn and Jurine, who regarded them as organs of which they knew not the use. They were then observed by M. de Candolle, who called them *raphides*, and gave a figure of them, which, however, is inaccurate. These crystals are really very regular tetraedrons. In many plants, as *Orchis, Pandanus, Ornithogalum, Jacinthus, Phytolacca decandra, Mesembryanthemum deltoides*, &c. they are very small, not being more than $\frac{1}{200}$ of a millimetre (.0002 of an inch) in width, $\frac{1}{10}$ (.004 of an inch) in length. But, in the tubercles of the Florence Iris, they are as much as $\frac{1}{50}$ (.0008 of an inch) in width, and $\frac{1}{3}$ (.01312 of an inch) in length, so as to be easily capable of examination.—*Bullet. Univ.* B. xi. 376.

9. *Iodine in Cadmium.*—Iodine is found in the great zinc foundry at Königshute, in Upper Silesia, in the cadmium which accompanies the zinc ores.—*Poggendorf's Journal.*

10. *New Mode of preserving crystals of Salts.*—Mr Deuchar, in a communication to the Wernerian Society, mentions, that crystals of efflorescent and deliquescent salts can be preserved from decay, if the air in the jars in which they are kept is impregnated with oil of turpentine. This is effected by pouring a very small quantity of the oil over the bottom of the jar.

GEOLOGY.

11. *Inflammable Gas arising after boring for Salt.*—In boring for salt at Rocky Hill, in Ohio, about a mile and a half

from Lake Erie, after proceeding to the depth of 197 feet, the auger fell, and salt water spouted out for several hours. After the exhaustion of this water, great volumes of inflammable air issued through the aperture for a long time, and formed a cloud; and, by ignition, occasioned by the fire in the shops of the workmen, consumed and destroyed every thing in the vicinity.—*Trans. of the Phil. Soc. of New York.*

12. *Inflammable Gas from Salt Mines, employed for producing Light.*—In the salt mine of Gottesgabe, at Rheine, in the county of Tecklenbourg, there has issued, for sixty years, from one of the pits (which has, on this account, been called the *Pit of the Wind*), a continued current of inflammable gas. The same gas is produced in other parts of the mines. M. Rœders, the inspector of the salt-mines, has used this gas for two years, not only as a light, but as fuel for all the purposes of cookery. He collects it in pits that are no longer worked, and conveys it in tubes to his house. It burns with a white and brilliant flame. Its density is about 0.66. It contains only traces of carbonic acid and sulphuretted hydrogen, and therefore should consist of carbonetted hydrogen and olefiant gas.—*Journal of Science.*

13. *Analysis of Peat.*—Bergsma has published, in Buchner's Repertorium, xxi. p. 498, an analysis of peat. He found it composed of the following substances:—Woody matter, 49.2; ulmin, 13.00; resinous matter, 1.80; oxide of iron, 0.42; silica, 3.8; sulphate of lime, 4.5; phosphat of lime 2.7; water, 12.5. Berzelius remarks, that the substance named ulmin by Bergsma, is nothing more than the extractive matter of soil, which, on account of its properties, is precipitated by acids. This peat affords, by distillation, 0.25 of empyreumatic ligneous acid, and 0.37 carbon.

14. *Geology of the Himalaya Mountains.*—"A very extensive report upon the geology of the Himalaya Mountains, by Captain Herbert, superintendent of the Geological Survey, was communicated by government to the society. The copiousness of this report did not admit of its being read, and the attention of the meeting was restricted to some of the principal results. The paper consists of an introduction and five sections. The first is chiefly geographical, and describes the physical aspect and arrangement; the second furnishes geological details; the

third takes a general view of the geological structure; the fourth exhibits the conclusions drawn by Captain Herbert, from his observations, as compared with theory and inquiries in other countries; and the fifth enumerates the mineral productions of the mountains, as far as yet ascertained. In the first division of his subject, Captain Herbert adverts to the supposed elevation of the great central table of Asia, whence arise so many considerable streams, and which, although surrounded by lofty barriers, is not necessarily of the great height which has been imagined. His observations, however, are restricted to a part only of the barrier, which is not among its least important portions. He estimates the superficial extent of the mountainous region, now comprised within the boundary of British India, at about 23,000 square miles. The whole of this is mountainous, but the mountains do not offer, to an ordinary observer, the idea of regular chains; and it is only with reference to the course of the rivers that their principal branches can be discriminated from each other. They are then distinguishable into different ranges, of which the Indo-Gangetic chain is the most extensive. With respect to elevation, Captain Herbert observes, that, whilst in South America, there is but one peak, Chimborazo, which exceeds 20,000 feet, and not more than five which are about 18,000; there are no fewer than twenty-eight peaks in the Himalaya, which overtop Chimborazo, one of which is about 25,000 feet, forty-four which exceed the three next of the American elevations, and more than a hundred which tower above the next in height: facts which he justly considers as more satisfactory proofs of the superior elevation of these mountains than the greater loftiness of an isolated summit. Through this range the only rock sufficiently extensive to be characteristic of its formation is gneiss, the other rocks occurring only in veins or beds. It occurs in three principal states, or laminated, granular, and what Captain Herbert terms glandular. Granite veins are numerous in some positions, but this mineral does not form a leading feature of these mountains, in which they offer a remarkable difference from the structure of the Andes. Various other differences, equally remarkable, occur, one of which is the total absence of volcanoes in the Hi-

malaya *. Captain Herbert considers, also, that no fossil remains are found within that tract of the Himalaya, which he regards as the tract of primitive formation, although ammonites are met with beyond the zone of gneiss; and with regard to the fossil bones, brought, as supposed, from the neighbourhood of the Niti Pass, nothing is known of their origin beyond the fact of their not having been discovered to the south of that pass. These bones were recognised by Professor Buckland as belonging to the same era as those of the caves, the history of which he has so ably illustrated. Our limits will not allow us to enter further into the details of this very interesting and important document, and we must content ourselves with enumerating the following as the mineral productions hitherto discovered in the mountains. They are sulphur, alum, plumbago, bitumen, gypsum, potstone, granite, borax, rock salt, gold dust in small quantities, copper, lead, and iron, in some abundance, and antimony, combined with lead and sulphur, and manganese with iron."—*Calc. Gov. Gaz.*

15. *Natural Gas-Lights at Fredonca.*—This village, on the shores of Lake Erie, is lighted every night by inflammable gas from the burning springs, as they are called, in its vicinity. Captain Hall has visited this village, and will no doubt give us an account of it on his return.

BOTANY.

16. *Eriophorum pubescens*, Smith.—This very rare species grows, in tolerable abundance, in a boggy field about three miles north of Berwick. It grows *in* the bog, and flowers in the months of June and July.

17. *Rhodiola and Scilla.*—Dr George Johnston of Berwick, has found the *Rhodiola rosea*, a northern plant, on Fast Castle, and on rocks near Berwick, being the most southerly station hitherto observed.—The Rev. A. Baird observes, that the *Scilla verna*, which is generally considered peculiar to our northern and western shores, grows plentifully on the seabanks at Gunsgreen, near Eyemouth.

* This statement affords a distinct contradiction to an account published in some of the Bengal papers, of a volcano said to have burst forth in the highest snowy peak of the Himalaya mountains, which excited much curiosity in Europe, and has led to some interesting speculations.

ZOOLOGY.

18. *Recovery from Drowning.*—M. Bourgeois had occasion to give assistance in a case where, after a person had been twenty minutes under water, he was taken out, and, by a very common, but serious mistake, carried with his head downwards. The usual means were tried unremittingly, but unsuccessfully, for a whole hour, but at the end of that time a little blood flowed from a vein that had been opened, and a ligature being placed on the arm, ten ounces of blood were withdrawn: the circulation and respiration were then gradually re-established, horrible convulsions, and a frightful state of tetanus, coming on at the same time; copious bleeding was again effected, after which a propensity to sleep came on: a third bleeding the following morning was followed by the recovery of the patient. Hence M. Bourgeois concludes, that the means of recovering a drowned person should never be abandoned until the decomposition of the body has commenced.—*Bull. Univ.* c. xi. 213.

19. *Preservation of Skins.*—A tanner in Hungary uses with great advantage the pyrolignous acid in preserving skins from putrefaction, and in recovering them when attacked. They are deprived of none of their useful qualities if covered by means of a brush with the acid, which they absorb verp readily.

20. *Stupendous Lizard.*—Mr Bullock, in his Travels (just published), relates, that he saw near New Orleans, "what are believed to be the remains of a stupendous crocodile, and which are likely to prove so, intimating the former existence of a lizard at least 150 feet long; for I measured the right side of the under jaw, which I found to be 21 feet along the curve, and 4 feet 6 inches wide; the others consisted of numerous vertebræ, ribs, femoral bones, and toes, all corresponding in size to the jaw; there were also some teeth; these, however, were not of proportionate magnitude. These remains were discovered a short time since, in the swamp near Fort Philip, and the other parts of the mighty skeleton are, it is said, in the same part of the swamp."

21. *Sea Serpents and Colossal Medusa.*—"I have read with great pleasure your very highly interesting communication about the sea serpent; as also, the very profound and learned disquisi-

tion on that and similar subjects, by your eminent friend, S. S. Duncan, Esq. (of Oxford.) Every person who has been much in the Bombay trade must have seen countless shoals of sea-serpents off that coast. I myself have seen them for hours accompanying the ship I was on board of in 1809, when going to Bombay, and every person I have spoken to on the point here, has appeared surprized that any doubt could exist about it. Those which I saw might be about 40 feet long, from estimation; they were beautifully coloured, and moved as rapidly as the ship, going seven or eight miles an hour: smaller ones still more common. On the coast of this island an immense *medusa* was thrown on shore, in a violent gale of wind, in 1819; it was within seven miles of my Belomber estate. It must have weighed many tons. I went to see it when the gale had subsided, which was not for three days after its being cast upon the sand, but it had already become offensive, and I could not distinguish any shape. The sea had thrown it high above the reach of the tide, and I instructed the fishermen who lived in the immediate neighbourhood to watch its decay, that if any osseous or cartilaginous part remained it might be preserved; it rotted, however, entirely, and left no remains. It could not be less than nine months before it entirely disappeared; and the travellers were obliged to change the direction of the road for nearly a quarter of a mile to avoid the offensive and sickening stench which proceeded from it."—*Extract of a Letter from C. Telfair, Esq. July 20. 1827, to R. Barclay, Esq. of Bury Hill.*

22. *Chinese method of fattening Fish.*—"The Chinese are celebrated for their commercial acumen, indefatigable industry, and natural adroitness, in making the most of every gift of nature bestowed on their fertile country. Useful as well as ornamental vegetables engross their every care; and animals which are the most profitably reared, and which yield the greatest quantity of rich and savoury food, are preferred by them for supplying their larders and stews. Their *hortus dietetica* would form a considerable list; and though they do not use such a variety of butcher's meat and fowl as Europeans do, yet, in the articles of pork, geese, and ducks, they surpass; in the use of fish they equal us; and in their domestication and management

of them, they excel all other nations. A few observations on their *piscinas*, or fish-stews, is the design of this paper; not merely as a historical description, but as an object for imitation in this or any other country. For twenty or thirty miles round Canton, and as far as the eye can reach on each side of the river on which that city stands, the general face of the country appears nearly a level plain, with but little undulation of surface. The level is, however, richly studded with beautiful hills, which diversify the landscape, and seem to rise out of the plain so abruptly, that they form the most picturesque features, united with the most pleasing combinations. The soil of the plain consists of a pure alluvial earth, of great fertility and depth, and very retentive of water; which, by the way, is a proof that, notwithstanding their claim to high chronological antiquity, the waters of the deluge remained much longer (perhaps for ages) on this portion of the continent of Asia, than it did in the interior: and the circumstance of many of their hills being cultivated to the very top, their numerous water-plants, and their almost amphibious habits as to their domiciles, are still further proofs that the country was once, more of an aquarium than it now is. Hence the facility of making canals, which are their high-roads (as wheel-carriages and beasts of draught are too expensive appendages for the systematic economy of the celestial empire!) and hence the ease with which a pond may be made in any otherwise useless corner. Such tanks, or ponds, are generally met with in market-garden grounds, where they serve the double purpose of a reservoir, and a stew for rearing and fattening fish. —When a pond is made for this purpose, and filled with water, the owner goes to market, and buys as many young store-fish as his pond can conveniently hold; this he can easily do, as almost all their fish are brought to market alive. Placed in the stew, they are regularly fed morning and evening, or as often as the feeder finds it necessary; their food is chiefly boiled rice, to which is added the blood of any animals they may kill, wash from their stewing-pots and dishes, &c.,—indeed, any animal offal or vegetable matter which the fish will eat. It is said they also use some oleaceous medicament in the food, to make the fish more voracious, in order to accelerate their fatten-

ing; but of this the writer could obtain no authentic account. —Fish so fed and treated, advance in size rapidly, though not to any great weight; as the kind (a species of perch) which came under observation, never arrive at much more than a pound avoirdupois; but from the length of three or four inches, when first put in, they grow from eight to nine in a few months, and are then marketable. Drafts from the pond are then occasionally made; the largest are first taken off, and conveyed in large shallow tubs of water to market; if sold, well; if not, they are brought back, and replaced in the stew, until they can be disposed of. This business of fish-feeding is so managed, that the stock are all fattened off about the time the water is most wanted for the garden crops. The pond is then cleaned out; the mud carefully saved, or spread as manure,—again filled with water, stocked with young fry, and fed as before. —An intelligent Chinaman, from whom the writer had the above detail, and who shewed him as much of the process as could be seen during a residence of three months, declared, as his belief, that a spot of ground, containing from twenty to thirty square yards, would yield a greater annual profit as a stew, than it would in any other way to which it could possibly be applied. —That fish may be tamed, suffer themselves to be caressed, and even raised out of their natural element by the hand, has been long known to naturalists; witness the famous old carp formerly in the pond of some religious house at Chantilly, in France, with many other instances on record. But it is probable no people has carried the art of stew-feeding fish, and practising it as a profitable concern, to such lengths, as is done by the Chinese at this day."—*Quarterly Journal of Science.*

23. *Leacia lacertosa.*—The animal described under this name in the Edinburgh Philosophical Journal, vol. xiii. p. 220, is the *Oniscus longicornis* of Sowerby's British Miscellany. As it is certainly not an *Oniscus*, the genus *Leacia*, suggested by Dr Johnston, ought to be allowed to remain.

GEOGRAPHY.

24. *Mr Cormack's Journey in search of the Red Indians.*—The following particulars of the expedition of our friend Mr

Cormack are extracted from the Newfoundland Journal of December last.—" That enterprising gentleman, W. E. Cormack, Esq. who, it will be remembered, left this place about the middle of September last, for the purpose of taking an excursion into the interior of the country, with a view to discover the retreat of the Red Indians, and with the ultimate object of introducing them to civilized life, returned to this town on Wednesday last, in a small schooner, from Twillingate. We have had some conversation with Mr Cormack, and the following may be regarded as a brief outline of the route which this gentleman has taken.—' Mr Cormack, accompanied by three Indians, entered the mouth of the river Exploits, at the north-west arm, and proceeded in a north-westerly direction, to Hall's Bay, distant about forty or fifty miles. At about half-way, namely, at Badger Bay Great Lake, he was encouraged by finding some traces, indicating that a party of the Red Indians had been at that place some time in the course of the preceding year. From Hall's Bay, a westerly direction into the interior was taken, and about thirty miles were traversed, towards Bay of Islands, and to the southward of White Bay; when, discovering nothing that could assist him in his inquiries there, Mr Cormack proceeded southwardly, to the Red Indians' Lake, where he spent several days, examining the deserted encampments, and the remains of the tribe. At this place were found several wooden cemeteries, one of which contained the remains of *Mary March* and her husband, with those of others; but, discovering nothing which indicated that any of the living tribe had recently been there, Mr Cormack rafted about seventy miles down the river, touching at various places in his way, and again reached the mouth of the Exploits, after an absence of thirty days, and having traversed nearly 200 miles of the interior, encompassing most of the country which is known to have been hitherto the favourite resort of the Indians. Mr Cormack is decidedly of opinion that the tribe have taken refuge in some sequestered spot in the neighbourhood of Bay Islands, west of White Bay, or in the south-west part of the island; and, having found where they are *not*, he apprehends very little difficulty in finding where they really are. Mr Cormack has engaged

three of the most intelligent of the other Indians to follow up his search in the ensuing year; and he feels persuaded that the pursuit will be ultimately attended with complete success.' "—*Ledger.*

25. *Mr Thomas Park's Journey into the Interior of Africa.*—Our young friend, and former pupil, Mr Park, son of the celebrated traveller Mungo Park, by this time far in the interior of Africa, writes to us as follows.—" *Accra, 17th September* 1827.—I intend to set off to-morrow morning. I have been nearly three months here, during which time I have been principally busy with the study of the Ashantee language. Some time ago I made an excursion of about fifty miles into the interior by way of experiment, and did not fail to look around me, and notice the rocks and other natural productions. I have only time to say, that the valley of Accra is about twelve miles in breadth, and fifty in length; the bottom is covered with a soft sandstone, and this sandstone in one place was observed resting upon clay-slate. The mountains bounding the sides of this long valley, as far as I could observe, appear composed of quartz-rock and clay-slate alternating with each other, and disposed in strata ranging SSW. and NNE., the dip from 30° to 80° (the direction of the dip not given). The quartz-rock contains grains of gold, as I ascertained by careful examination. In some blocks of rock (syenite) I noticed a good many crystals of sphene, and in one place I saw what I imagined to be black manganese ore. It is very hard and heavy, and is fashioned by the Ashantees into balls. The cover of alluvium, in the bottom of the valley, and extending down to the sea-coast, is of such a nature as to lead me to conjecture that it is of marine origin, and, therefore, that the sea formerly extended a long way inland. The bases of the hills are richly clothed with trees; but these diminish in number towards the coast, where there occur only a bush here and there."

ARTS.

26. *Manufacture of Ultramarine.*—M. Gay Lussac announced to the Academy, that M. Tunel, inspector of gunpowder and saltpetre, had succeeded in the direct formation of ultramarine,

and that what he obtains by this process is finer and more brilliant than the natural colour. It was by following the analysis made by M. Clement Desormes that the inventor accomplished this desirable object. M. Tunel has already been able to supply the public with ultramarine at 25 francs the ounce; the colour having hitherto been sold for 50 or 60 francs the ounce. He hopes that he shall be able to sell it at a still more moderate price. M. Tunel has thought proper to keep this process secret for a certain time.—*Le Globe, Fev.* 9. 1828.

27. *St Helena Silk.*—A specimen of the raw silk, produced at the island of St Helena, has arrived in England. It is the first perfect one, and is considered to be of a very fine quality. It is entirely free from any disagreeable odour, which speaks much in its favour. In last August the number of worms in progress was 218,000, which were in a very healthy condition, and expected to spin in the course of a few days. The mulberry trees thrive remarkably well, and have a very luxuriant appearance.

28. *Size and Value of Mahogany.*—" Three boats were each cut out of a single tree, one mahogany, the other cedar, measuring about thirty-five feet in length, nearly six feet in breadth, and above five feet in depth. Few people are acquainted with the immense size and value of some logs of mahogany brought to this country. The following may serve as an example: " The largest and finest log of mahogany ever imported into this country has been recently sold by auction at the docks in Liverpool. It was purchased by James Hodgson, Esq. for L. 378, and afterwards sold by him for L. 525, and, if it open well, it is supposed to be worth L. 1000. If sawn into veneers, it is computed that the cost of labour in the process will be L. 750. The weight on the King's beam is six tons thirteen hundred weight."—*Roberts' Voyages to the East Coast of Central America in Constable's Miscellany.*

NEW PUBLICATIONS.

29. *Illustrations of Zoology*; by J. WILSON, Esq. F.R.S.E. M.W.S.—The third Number of this beautiful and classical work has made its appearance; but want of room forces us to

delay, until next Number, our notice of it, and of other works now before us.

30. *A History of British Animals, exhibiting the descriptive characters and systematical arrangement of the Genera and Species of Quadrupeds, Birds, Reptiles, Fishes, Mollusca, and Radiata of the United Kingdom; including the Indigenous, Extirpated, and Extinct Kinds, together with periodical and occasional visitants.* By JOHN FLEMING, D.D. F.R.S.E. M.W.S. &c. Minister of Flisk, Fifeshire; and Author of the "Philosophy of Zoology." This very important work, which has just appeared, we consider as infinitely superior to any Natural History of British Animals hitherto published. It will become the standard book on British animals. Dr Fleming's acuteness in the investigation of species, his accuracy in description, and general learning in zoology, are already well known. The present Fauna of Britain cannot fail to extend his celebrity.

31. *Elements of Natural History, adapted to the present state of the Science.* By JOHN STARK, F.R.S.E. & M.W.S — This work, of which the first volume is already printed, is intended as an introduction to the study of natural history in its several branches. Besides general observations on the structure of each class, explanations of terms, and references to the text books, the generic characters of the whole animal kingdom will be given, and descriptions of the principal species, particularly those of Europe. To the scientific details, are added, in many instances, popular remarks on the more important or interesting animals; and the fossil species are noticed.

32. *Sketches of the Maritime Colonies of British America.* —Mr Macgregor, a gentleman well acquainted with our American colonies, has nearly ready for publication a work on our North American possessions.

List of Patents granted in England from 22d November 1827 *to* 31*st January* 1828.

1827,

Nov. 22. To R. WHEELER of High Wycomb, for "improvements on Refrigerators for cooling fluids."

To W. J. DOWDING of Poulshot, Wiltshire, for "improvements in Machinery for rollering Wool from the carding engine."

Nov. 24. To J. Roberts of Wood Street, Cheapside, and G. Upton of Queen Street, Cheapside, for "improvements on Argand and other Lamps."

26. To J. A. Fulton of Lawrence Pountney Lane, Cannon Street, London, for "a process of preparing or bleaching Pepper."

27. To J. Apsey of John Street, Waterloo Road, Lambeth, for "an improvement in Machinery to be used as a substitute for a Crank."

28. To J. Jenour junior of Brighton Street, St Pancras, for his "Cartridge or Case, and Method of more advantageously inclosing therein shot or other missiles, for loading fire-arms."

Dec. 4. To T. Bonnor of Monkwearmouth Shore, Durham, merchant, for "improvements on Safety Lamps."

To W. Fawcett of Liverpool, and M. Clark of Jamaica, for "improved apparatus for the better manufacture of Sugar from the Canes."

To R. W. Winfield of Birmingham, for his "improvements in Tubes or Rods, produced by a new method of manufacturing, and in the construction only, and for manufacturing the same, with various other improvements, into parts of bedsteads, and other articles."

To J. Meadon of Millbrook, near Southampton, for "improvements on Wheels for Carriages."

To S. Wilkinson of Holbeck, Yorkshire, for "improvements on Mangles."

To Maurice de Jough of Warrington, cotton-spinner, for "improvements in Machines adapted for spinning, doubling, twisting, roving, or preparing cotton," &c.

To T. Tyndall of Birmingham, for "improvements in the manufacture of Buttons, and in the Machinery for manufacturing the same;" communicated from abroad.

To D. Ledsam and W. Jones of Birmingham, for "improvements in Machinery for cutting sprigs, brads and nails."

To J. Robinson of Merchants' Row, Limehouse, for "an improvement in the manufacture of Brushes of certain descriptions, and in the manufacture of a material and the application thereof to the manufacture of Brushes, and other purposes."

11. To Paul Steenstrup of Basing Lane, London, Esq. for "improvements in Machinery for propelling Vessels, and other purposes."

13. To J. H. Sadler of Hoxton, Middlesex, for "improvements in Power-Looms."

To R. Newcastle of Newcastle-upon-Tyne, for "an improved method of Ballasting ships or vessels."

To R. Stein of Regent Street, Oxford Street, for "an improvement in applying Heat to the purpose of Distillation."

To J. B. Geithner of Birmingham, for "improvements on Castors for furniture," &c.

To H. Peto of Little Britain, for "an apparatus for generating power."

Dec. 13. To J. A. BEROLLAS of Nelson Street, City Road, for "a method of Winding up a pocket Watch or Clock without a key, which he calls "Berollas's Keyless Watch or Clock;" and also a certain improvement to be applied to his late invented detached Alarum-watch."

To Lieut. A. M. SKENE of Jermyn Street, for "an improvement in propelling Vessels, and for working undershot Water-mills."

18. To J. L. STEVENS of Plymouth, for "a new Method of propelling Vessels by the aid of Steam, or other means, and for its application to other purposes."

To T. TYNDALL of Birmingham, for "improvements in the Machinery for making nails, brads and screws; communicated from abroad."

To J. GEORGE of Chancery Lane, Esquire, barrister-at-law, for his "invention for preserving Decked Ships or Vessels, so as to render them less liable to dry-rot, and for preserving goods on board such ships and vessels from damage by heat."

19. To T. S. HOLLAND of the city of London, Esquire, for "combinations of Machinery for generating and communicating Power and Motion, applicable to propelling of fixed machinery, as also floating bodies, carriages, and other locomotive engines."

21. To W. HARLAND, M. D. of Scarborough, for "improvements in Apparatus for propelling Locomotive Carriages; which improvements are also applicable to other useful purposes."

22. To C. A. FURGUSTON of Mill Wall, in the parish of All Saints, Poplar, mast-maker, and J. FALCONER ATLEE of Prospect Place, Deptford, for their "improvements in the construction of made Masts."

27. To W. HALE of Colchester, for his "improvements in Machinery for propelling Vessels."

828,

n. 2. To W. GOSSAGE of Leamington Priors, Warwickshire, for "improvements in the construction of Cocks for the passage of Fluids."

To T. BOTFIELD of Hopton Court, Salop, for "improvements in making Iron, or in the method or methods of smelting and making of Iron."

To J. HALL *junior* of Ordsall, near Manchester, for "improvements in Dyeing Piece Goods by machinery."

To J. CL. DANIELL of Stoke, Wilts, for "improvements in Dressing Cloths, and in the machinery applicable for that purpose."

9. To W. MORLEY of Nottingham, for "improvements and additions to Machinery now in use for making Lace or Net."

To J. A. HUNT GRUBBE of Stanton, St Bernard, Wilts, clerk, for "a transmitting Heat Wall for the ripening of Fruit."

15. To J. GILBERTSON of Hertford, for "an improvement in the construction of Furnaces, by which they consume their own smoke."

To C. HOOPER of Spring Gardens, in the parish of Marston Bigott,

To J. EVANS the younger, of Moreton Mills, near Wallingford, Berks, for "improvements on Steam-Engines."

Somersetshire, for "an improved Machine for shearing and cropping Woollen and other Cloths."

Jan. 15. To J. Blades of Clapham, Surrey, for "an improvement in the Water Proof Stiffening for Hats; communicated from abroad."

To W. Newton of Chancery Lane, for "an improved surgical Chair-bed, with various appendages."

To G. D. Harris of Field Place, near Stroud, Gloucestershire, for "improvements in Dressing and Preparing Woollen Yarns, and cleaning, dressing and preparing woollen cloths, &c. and in the apparatus for performing the same."

To J. Falconer Atlee of Prospect Place, Deptford, for "improvements on Bands or Hoops for securing made and other masts, bowsprits and yards, and applicable to other purposes."

To W. Erskine Cochrane, Esq. of Regent Street, for "improvements in certain apparatus for Cooling, and other purposes."

19. To J. Taylor Beale of Church Lane, Whitechapel, and G. Richardson Porter of Old Broad Street, for "their new mode of communicating Heat, for various purposes."

To W. Percival of Knightsbridge, for "improvements in the construction and application of Shoes, without nails, to the feet of horses, and certain other animals."

To G. Jackson of St Andrew, Dublin, for "improvements in Machinery for propelling Boats and other Vessels; which improvements are also applicable to Water Wheels, and other purposes."

2. To J. Weiss of the Strand, for "improvements on Instruments for bleeding horses and other animals."

To Augustus Applegath of Crayford, Kent, for his "improvements in Block-printing."

31. To Donald Currie of Regent Street, Esquire, for "a method of preserving Grain, and other vegetable and animal substances and liquids."

List of Patents granted in Scotland from 6th December 1827 to 23d February 1828.

1827,

Dec. 6. To Joshua Jenour *junior* of Brighton Street, in the parish of St Pancras, Middlesex, gentleman, for "a Cartridge or Case, and method of more advantageously inclosing therein Shot or other missiles, for the purpose of loading fire-arms and guns of different descriptions."

1828,

Jan. 4. To Robert Wheeler of High Wycome, in the county of Bucks, brewer, for "an improvement or improvements on or in Refrigerators for cooling Fluids."

Jan. 4. To Thomas Bonner of Monkwearmouth Shore, in the county of Durham, merchant, for an "improvement in Safety Lamps."

10. To William Parkinson of Barton-upon-Humber, in the county of Lincoln, gentleman, and Samuel Crossley of Cottage Lane, City Road, in the county of Middlesex, gas apparatus manufacturer, for "an improved method of constructing and working an Engine for producing power and motion."

17. To William Nairn of Davie Street, Edinburgh, in the county of Mid-Lothian, wright, for "a new or improved method or methods of propelling Vessels through or on the water by the aid of Steam or other Mechanical Force."

22. To George Dickinson of Buckland Mill, near Dover, in the county of Kent, paper-maker, for "an improvement or improvements in making paper by machinery."

29. To Ralph Rewcastle of Newcastle-upon-Tyne, mill-wright, for "a new and improved method of Ballasting Ships or Vessels."

Feb. 13. To Robert Stein of Regent Street, Oxford Street, in the county of Middlesex, for "an improvement in applying Heat to the purpose of Distillation."

To Thomas Bousor Crompton of Farnworth, in the county of Lancaster, paper-maker, for "certain improvements in that part of the process of paper-making which relates to the cutting."

23. To George Jackson of St Andrew's Street, in the city of Dublin, attorney-at-law, for "certain improvements in Machinery for propelling Boats and other Vessels; which improvements are also applicable to water-wheels, and other purposes."

LIST OF PLATES IN THIS VOLUME

The Plate (belonging to preceding Volume) illustrative of Mr Blackadder's Account of the Aurora borealis of January 1827, is also given with this Number.

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